TECHNICAL REFERENCE NOTE

ARTESYN HPS3000 SERIES

3000 Watts Distributed Power System

PRODUCT DESCRIPTION

Advanced Energy's Artesyn HPS3000 series bulk front end AC-DC power supply accepts a wide range 90 to 264Vac input and provides a main 48V output plus a 5V standby output. It has a full load efficiency of more than 90% and is rated at 3,000 watts when operating from a nominal 200Vac input. Housed in a 1U x 4.2 in form factor enclosure, the power supply has a power density of 40 watts per cubic in; four units can fit on a standard 19 in rack shelf, to provide a total of 12 kilowatts.

AT A GLANCE

Total Power

3000 Watts

Input Voltage

90 to 264 Vac

of Outputs

Main and Standby

SPECIAL FEATURES

- 3000W output power
- 40W/in^3
- Optional customer provided air
- 1U x 3U form factor
- N+1 redundant
- Hot-swap
- Internal OR-ing
- 5V housekeeping
- High efficiency 89% @ 200 Vac, 100% load
- Variable speed “smart fans”
- Two years warranty
- EMI Class A - EN55032, Level “A”
- EN61000 immunity

SAFETY

- UL/cUL 62368-1
- CSA 62368-1
- China CCC
- NEMKO TUV
- CB Report
- CSA 22.2 62368-1
- UKCA Mark

TYPICAL APPLICATIONS

- Industrial

MODEL NUMBERS

Standard	Output Voltage	Minimum Load	Maximum Load	Stand-By Supply	Air Flow Direction
HPS3000-9	48.0Vdc	0A	62.5A	5V @ 3A	Normal (Handle to Connector)
HPS3000-9-001	48.0Vdc	0A	62.5A	5V @ 3A	Reverse (Connector to Handle)

Note: HPS3000-9-001 version is recommended for applications where higher airflow is required.

Options

None

ELECTRICAL SPECIFICATIONS

Absolute Maximum Ratings

Stress in excess of those listed in the "Absolute Maximum Ratings" may cause permanent damage to the power supply. These are stress ratings only and functional operation of the unit is not implied at these or any other conditions above those given in the operational sections of this TRN. Exposure to any absolute maximum rated condition for extended periods may adversely affect the power supply's reliability.

Table 1. Absolute Maximum Ratings

Parameter	Models	Symbol	Min	Typ	Max	Unit
Input Voltage						
AC continuous operation	All models	$V_{IN,AC}$	90	-	264	Vac
Maximum Output Power (Main + Stand-by)						
$V_{I,AC} \leq 180$Vac	All models	$P_{O,max}$	-	-	1500	W
$V_{I,AC} > 180$Vac	All models	$P_{O,max}$	-	-	3000	W
Isolation Voltage						
Input to outputs	All models		-	-	2500	Vdc
Input to safety ground	All models		-	-	2500	Vdc
Output to safety ground	All models		-	-	50	Vdc
Ambient Operating Temperature	All models	T_A	-10	-	40	°C
Storage Temperature	All models	T_{STG}	-40	-	85	°C
Humidity (non-condensing)						
Operating	All models		5	-	95	%
Non-operating	All models		5	-	95	%
Altitude						
Operating	All models		-	-	10000	Feet
Non-operating	All models		-	-	30000	Feet
MTBF[1]	All models		270	-	-	Khours
Operating Life[2]	All models		10			Years

Note 1: 270K hours using the Telcordia specification @ 25°C and 135K hours @ 40°C, ambient, at full load.
Note 2: With the power supply installed in a system in a 25°C ambient environment and operating at full load, capacitor life shall be 10 years, minimum for ALL electrolytic capacitors contained within this power supply.

ELECTRICAL SPECIFICATIONS

Input Specifications

Table 2. Input Specifications

Parameter	Condition	Symbol	Min	Typ	Max	Unit
Operating Input Voltage, AC	All	$V_{IN,AC}$	90	115/230	264	Vac
Input AC Frequency	All	$f_{IN,AC}$	47	50/60	63	Hz
Maximum Input Current ($I_O = I_{O,max}$, $I_{SB} = I_{SB,max}$)	$V_{IN,AC}$ = 90Vac $V_{IN,AC}$ = 180Vac	$I_{IN,max}$	- -	- -	23 22	A A
Standby Input Current (V_O = Off, I_{SB} = 0A)	$V_{IN,AC}$ = 90Vac $V_{IN,AC}$ = 180Vac	$I_{IN,standby}$	- -	- -	500 500	mA mA
No Load Input Current (V_O = On, I_O = 0A, I_{SB} = 0A)	$V_{IN,AC}$ = 90Vac $V_{IN,AC}$ = 180Vac	$I_{IN,no-load}$	- -	- -	600 600	mA mA
Harmonic Line Currents	$V_{IN,AC}$ = 230V_{AC} $I_O \geq 0.5\ I_{O,max}$	THD	Per IEC 61000-3-2			
Power Factor	All	PF	-	0.97	-	
Startup Surge Current (Inrush) @ 25°C	$V_{IN,AC}$ = 264Vac		-	-	40	Apk
Input Fuse	Internal, L and N 25A, 250V		-	-	25	A
Isolation - Input to Output			-	2500	-	Vdc
Isolation - Input to Chassis			-	2500	-	Vdc
Isolation - Output to Chassis			-	50	-	Vdc
Isolation - Output to Standby			-	50	-	Vdc
Leakage Current to Earth Ground	$V_{IN,AC}$ = 240Vac $f_{IN,AC}$ = 50/60Hz		-	-	1.4	mA
PFC Switching Frequency	All	$f_{SW,PFC}$	75	80	85	KHz
DCDC Switching Frequency	All	$f_{SW,DC-DC}$	140	145	150	KHz
Operating Efficiency @ 25°C	$V_{IN,AC}$ = 200Vac $I_O = I_{O,max}$	η	89	-	-	%
System Stability Phase Margin Gain Margin	$V_{IN,AC}$ = 180/264Vac $f_{IN,AC}$ = 47/63Hz Io = 10% to 100% $I_{O,max}$ Co = 3000uF		 45 10	 - -	 - -	 ∅ dB

ELECTRICAL SPECIFICATIONS

Output Specifications

Table 3. Output Specifications

Parameter	Condition	Symbol	Min	Typ	Max	Unit
Output Regulation	Inclusive of set-point, temperature change, warm-up drift and dynamic load	V_O	95	-	105	$\%V_O$
		V_{SB}	4.8	5.0	5.2	V
Output Ripple, pk-pk	Measure with a 0.1uF ceramic capacitor in parallel with a 10uF tantalum capacitor, 0 to 20MHz bandwidth.	V_O	-	-	480	mV_{PK-PK}
		V_{SB}	-	-	100	mV_{PK-PK}
Output Current	$V_{IN,AC} \leq 180Vac$ $V_{IN,AC} > 180Vac$	I_O	0 0	- -	31.25 62.50	A
		I_{SB}	0	-	3	A
Main Output Current Share Accuracy	20% to 100% $I_{O,max}$		-	-	10	$\%I_{O,max}$
Main Output Minimum Current Share Loading	All		20	-	-	$\%I_{O,max}$
Main Output Adjustable Range	Via I^2C	V_O	96	-	117	$\%V_O$
Main Output Load Capacitance (Start up)	Signal unit		-	-	3000	uF
	2 units in parallel		-	-	6000	uF
	3 units in parallel		-	-	9000	uF
	4 units in parallel		-	-	12000	uF
Standby Output Load Capacitance (Start up)			-	-	200	uF
Main Output Dynamic Response Peak Deviation Setting Time	50% load change, slew rate = 1A/uS	$\pm\%V_O$ t_s	- -	- -	5 800	% mSec
V_O Long Term Stability Max change over 24 hours	After thermal equilibrium (30 mins)	$\pm\%V_O$			0.2	%
Hot Swap Cycle	$V_{IN,AC}$ = 264Vac $I_O = I_{O,max}$		-	-	50	Cycle

ELECTRICAL SPECIFICATIONS

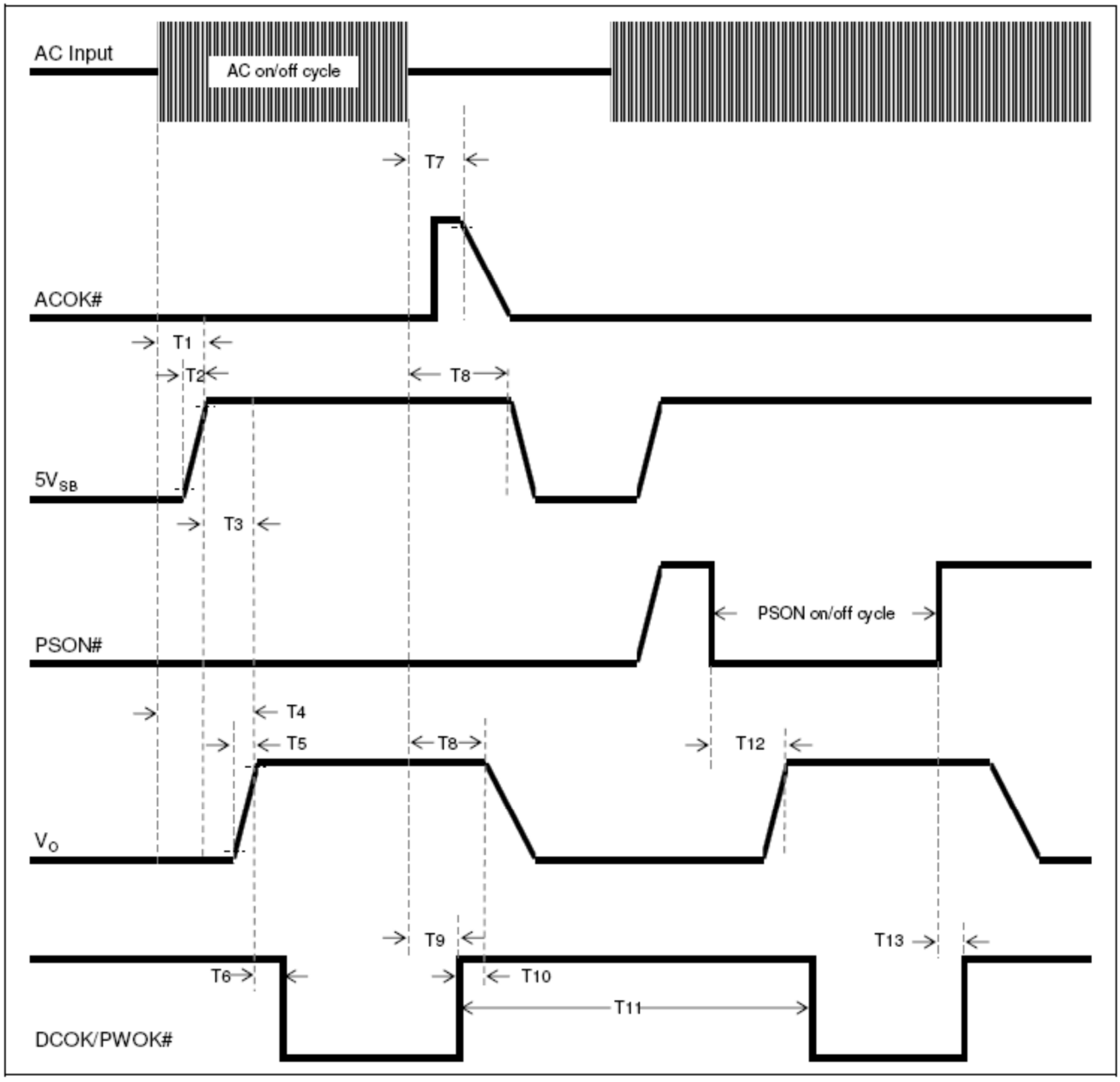
System Timing Specifications

Table 4. System Timing Specifications

Label	Parameter	Min	Typ	Max	Unit
T1	Delay from AC being applied to 5Vsb being within regulation	-	-	1500	mSec
T2	Standby rise time	-	-	5	mSec
T3	Delay from 5Vsb being in regulation to 48Vdc being in regulation at AC turn on	50	-	2000	mSec
T4	Delay from AC being applied to all output voltages being within regulation	-	-	2000	mSec
T5	Output voltage rise time from each main output	5	-	300	mSec
T6	Delay from output voltages within regulation limits to DCOK/PWOK# asserted at turn on	100	-	1000	mSec
T7	Delay from loss of AC input to de-assertion of ACOK#	10	-	-	mSec
T8	Time all output voltages, including 5Vsb, stay within regulation after loss of AC	10	-	-	mSec
T9	Delay from loss of AC to de-assertion of DCOK/PWOK#	5	-	-	mSec
T10	Delay from DCOK/PWOK# de-asserted to 48Vdc or 5Vsb dropping out of regulation limits	1	-	1000	mSec
T11	Duration of DCOK/PWOK being in the de-asserted state during an off/on cycle using AC or the PSON# signal	100	-	-	mSec
T12	Delay from PSON# active to output voltages within regulation limits	5	-	400	mSec
T13	Delay from PSON# inactive to DCOK/PWOK# being de-asserted	-	-	50	mSec

ELECTRICAL SPECIFICATIONS

System Timing Diagram



ELECTRICAL SPECIFICATIONS

HPS3000-9 Performance Curves

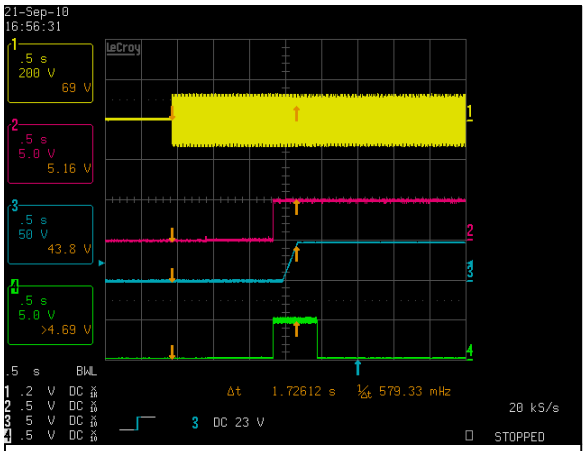


Figure 1: HPS3000-9 Turn-On Delay via AC Mains
Vin = 90Vac Load: I_O = 31.25A I_{SB} = 3A (5V)
Ch 1: AC Mains Ch 2: V_{SB} Ch 3: V_O Ch 4: PWOK

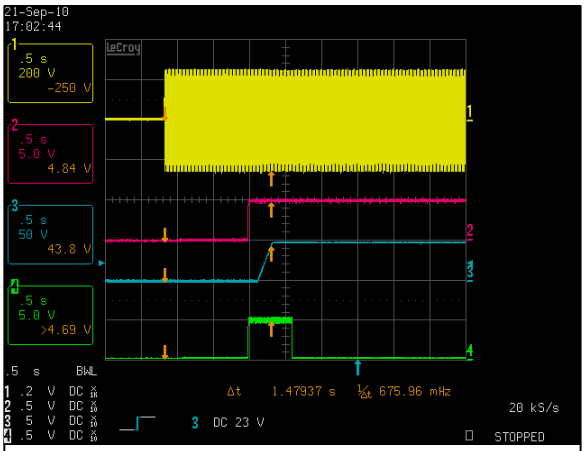


Figure 2: HPS3000-9 Turn-On Delay via AC Mains
Vin = 180Vac Load: I_O = 62.5A I_{SB} = 3A (5V)
Ch 1: AC Mains Ch 2: V_{SB} Ch 3: V_O Ch 4: PWOK

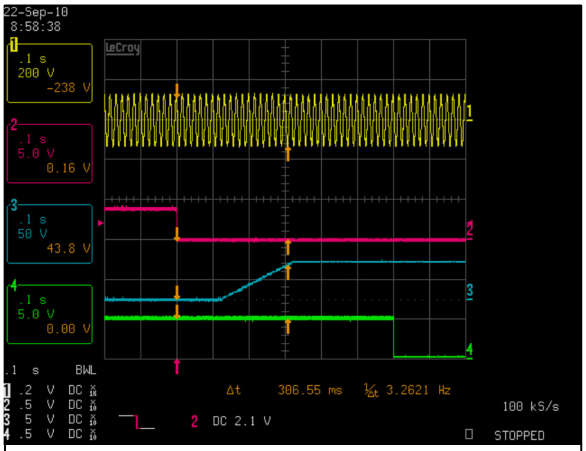


Figure 3: HPS3000-9 Turn-on delay via PSON
Vin = 90Vac Load: Io = 31.25A I_{SB} = 3A (5V)
Ch 1: AC Mains Ch 2: PSON Ch 3: V_O Ch 4: PWOK

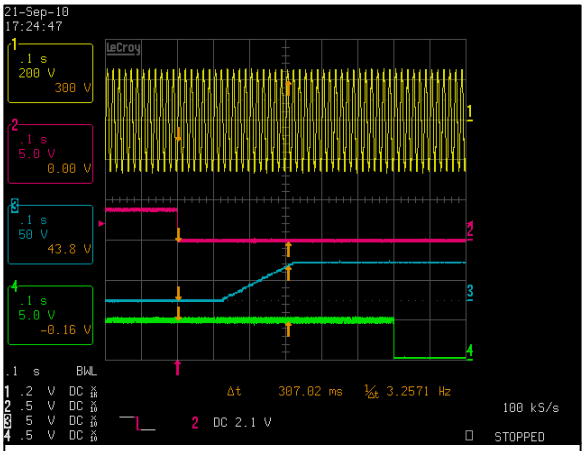


Figure 4: HPS3000-9 Turn-on delay via PSON
Vin = 180Vac Load: Io = 62.5A I_{SB} = 3A (5V)
Ch 1: AC Mains Ch 2: PSON Ch 3: V_O Ch 4: PWOK

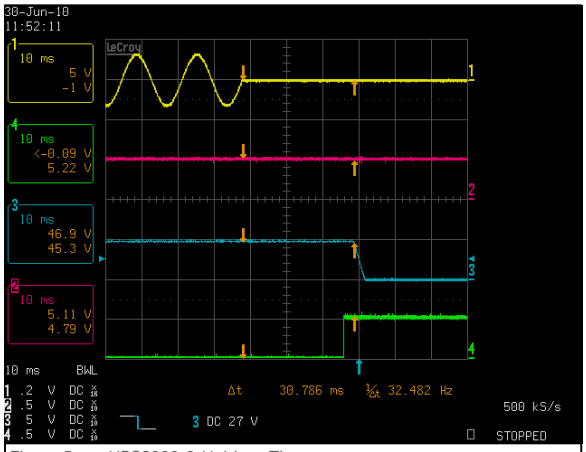


Figure 5: HPS3000-9 Hold-up Time
Vin = 90Vac/0° fin = 63Hz Load: I_O = 31.25A I_{SB} = 3A (5V)
Ch 1: AC Mains Ch 2: VSB Ch 3: VO Ch 4: PWOK

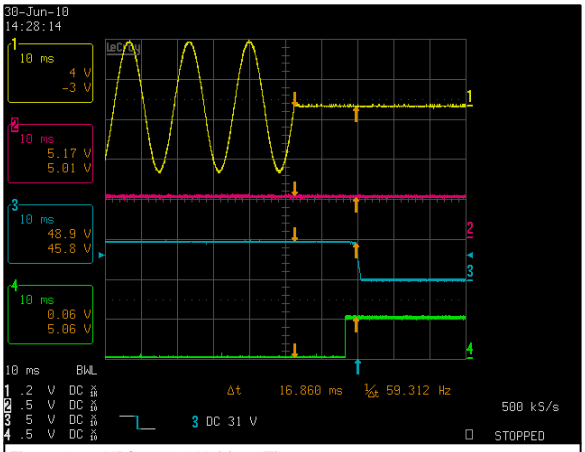


Figure 6: HPS3000-9 Hold-up Time
Vin = 264Vac/0° fin = 47Hz Load: I_O = 62.5A I_{SB} = 3A (5V)
Ch 1: AC Mains Ch 2: V_{SB} Ch 3: V_O Ch 4: PWOK

ELECTRICAL SPECIFICATIONS

HPS3000-9 Performance Curves

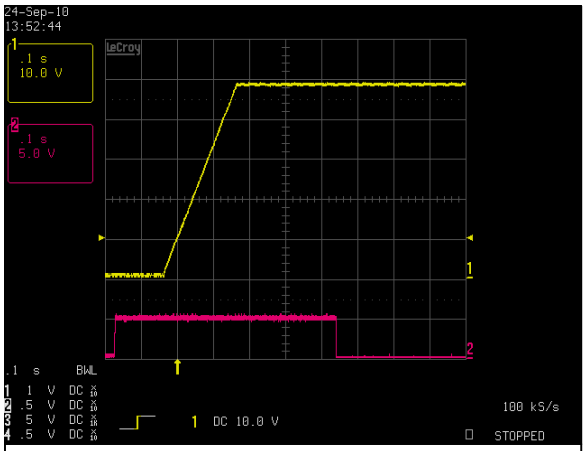


Figure 7: HPS3000-9 Output Voltage Startup Characteristic
Vin = 90Vac Load: I_O = 31.25A I_{SB} = 3A (5V)
Ch 1: V_O Ch 2: PWOK

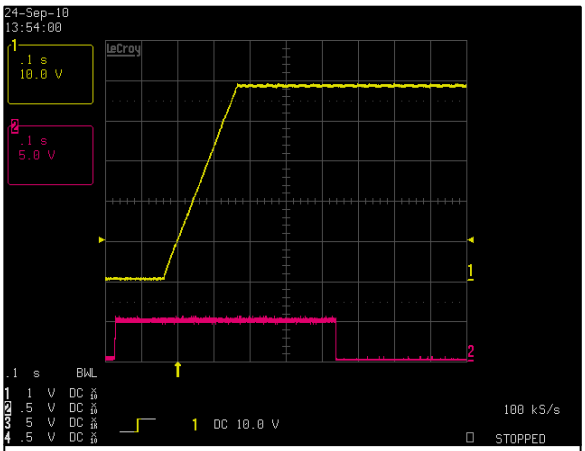


Figure 8: HPS3000-9 Output Voltage Startup Characteristic
Vin = 180Vac Load: I_O = 62.5A I_{SB} = 3A (5V)
Ch 1: V_O Ch 2: PWOK

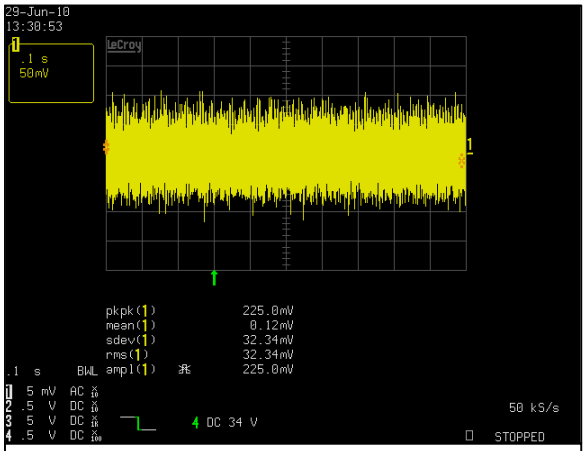


Figure 9: HPS3000-9 Ripple and Noise Measurement
Vin = 90Vac Load: I_O = 31.25A I_{SB} = 3A (5V)
Ch 1: V_O

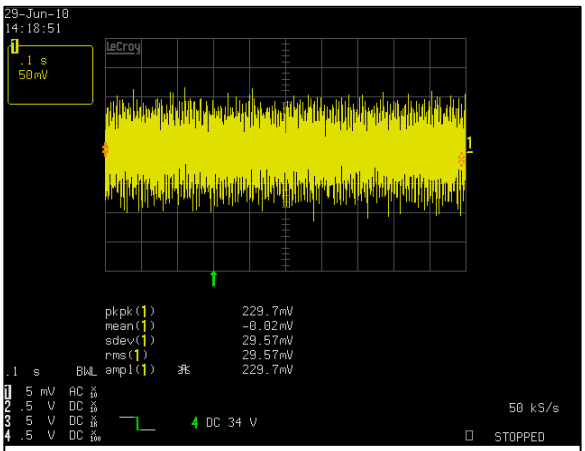


Figure 10: HPS3000-9 Ripple and Noise Measurement
Vin = 230Vac Load: I_O = 62.5A I_{SB} = 3A (5V)
Ch 1: V_O

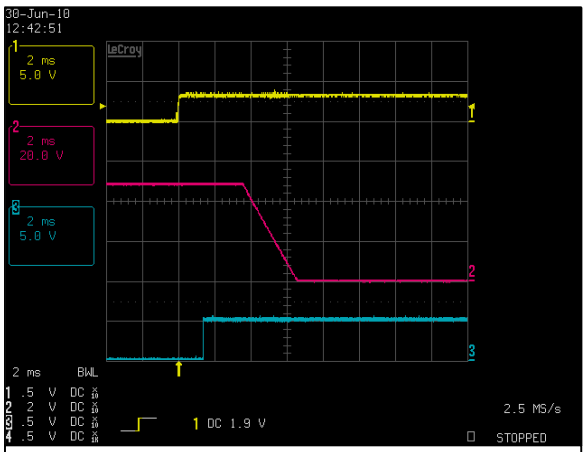


Figure 11: HPS3000-9 Turn Off Characteristic via PSON
Load: I_O = 62.5A I_{SB} = 3A (5V)
Ch 1: PSON Ch 2: V_O Ch 3: PWOK

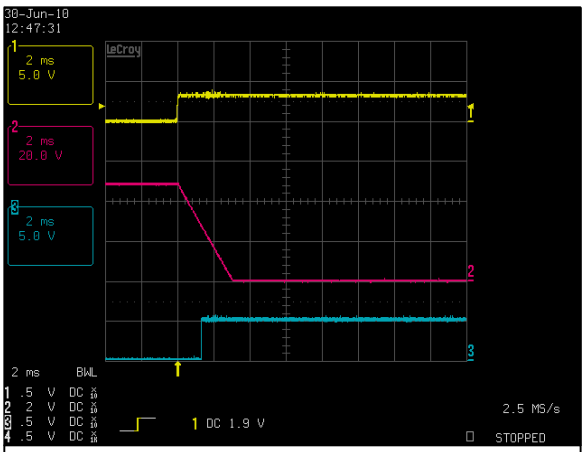


Figure 12: HPS3000-9 Turn Off Characteristic via PSKILL
Load: I_O = 62.5A I_{SB} = 3A (5V)
Ch 1: PSKILL Ch 2: V_O Ch 3: PWOK

ELECTRICAL SPECIFICATIONS

HPS3000-9 Performance Curves

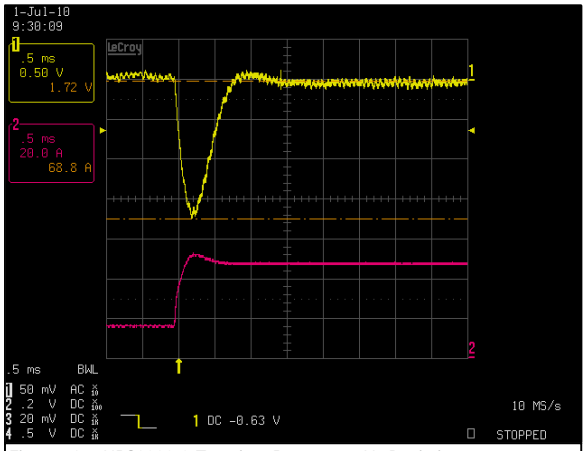


Figure 13: HPS3000-9 Transient Response - V_O Deviation
25% to 75% load change 1A/uS slew rate Vin = 230Vac
Ch 1: V_O Ch 2: I_O

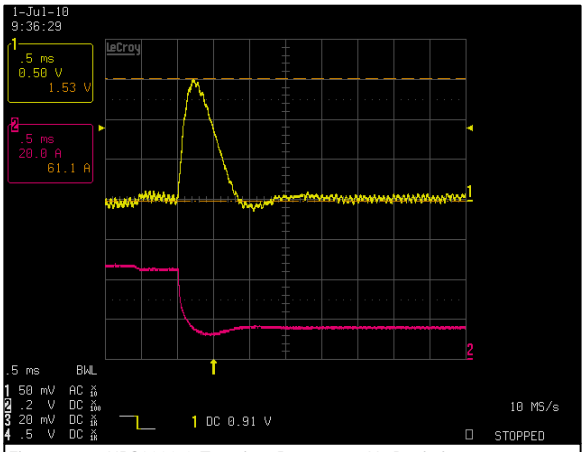


Figure 14: HPS3000-9 Transient Response - V_O Deviation
75% to 25% load change 1A/uS slew rate Vin = 230Vac
Ch 1: V_O Ch 2: I_O

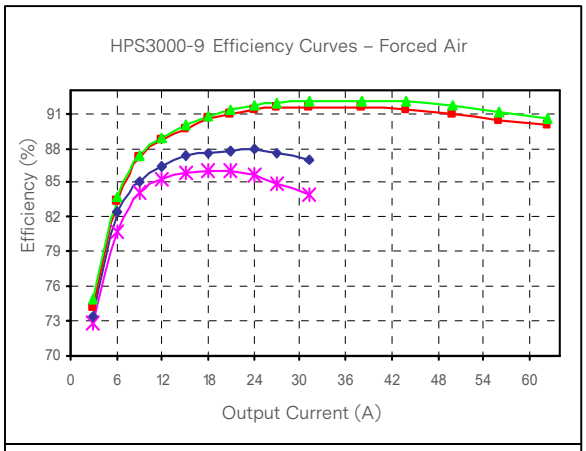


Figure 15: HPS3000-9 Efficiency Curve @ 25°C
90Vac 120Vac 230Vac 264Vac
Loading: I_{o_main} = 10%$I_{o,max}$ increment to 62.5A, I_{SB} = 0A

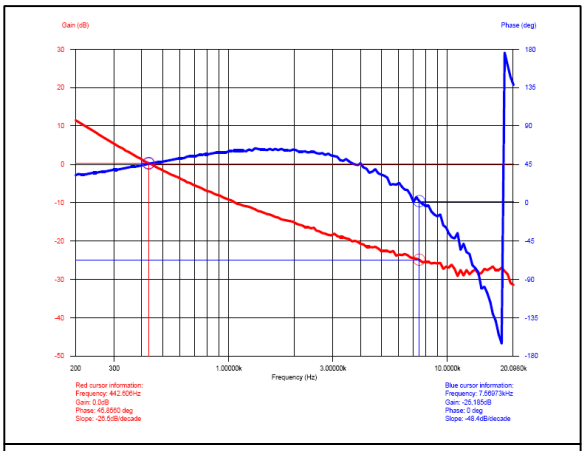


Figure 16: HPS3000-9 Gain-Phase Analysis
Vin = 180Vac fin = 63Hz I_O = 62.19A Capacitance Load = 3000uF
Red Cursor = Gain (dB), Blue Cursor = Phase (deg)

ELECTRICAL SPECIFICATIONS

Protection Function Specifications

Input Fuse

HPS3000 series are equipped with an internal non user serviceable 25A High Rupturing Capacity (HRC) 250Vac fuse to IEC 127 for fault protection in both the L1 and L2 lines input.

Over Voltage / Under Voltage Protection (OVP / UVP)

The power supply latches off during output overvoltage with the AC line or PSON# recycling to reset the latch.

OVP

Parameter	Min	Max	PMBus™ Register Value at Fault			
			0x78h	0x79h	0x7Ah	0x80h
V_O Output Overvoltage	52.8V	64V	60	8860	80	00
V_{SB} Output Overvoltage	5.5V	6.25V	40	1840	00	48

UVP

Parameter	Min	Max	PMBus™ Register Value at Fault			
			0x78h	0x79h	0x7Ah	0x80h
V_O Main Undervoltage	41.0V	44.8V	40	8840	10	00

Over Temperature Protection (OTP)

The power supply is protected against over temperature conditions caused by a loss of fan cooling or excessive ambient temperature. In an OTP condition, the power supply shall be shutdown with the exception of the 5Vsb output. When the power supply temperature drops to within specified limits, the power supply shall restore the +48Vdc output automatically. The OTP circuit must have built in hysteresis such that the power supply will not oscillate on and off due to temperature recovering condition.

ELECTRICAL SPECIFICATIONS

Over Current Protection (OCP)

HPS3000 series include internal current limit circuitry to prevent damage in the event of over current or short circuit.

OCP

Parameter	Input Voltage	Min	Nom	Max	Unit
V_O Output Overcurrent	180Vac	75.0	/	81.25	A
V_{SB} Output Overcurrent	180Vac	3.3	/	4.2	A

If an overload condition occurs to the 48V main output, the 48V main output will shut down and latch off. The 5V V_{SB} will remain ON. The Power LED will be solid green and the Fail LED will be blinking Amber. The PMBus™ registers will indicate the fault with the following values:

0x78h = 51
0x79h = 58 51 or 48 51
0x7Bh = A0

When the over load condition is removed, the power supply can be restarted by AC power or PSON# recycling.

If an overload condition occurs to the 5V V_{SB} output, the power supply will shut down with 48V main output turned off. The power supply (both 48V main output and 5V V_{SB}) will recover automatically when the fault condition cleared. While the fault condition exists, the power LED will be OFF and the fail LED will be solid amber. The PMBus™ registers will indicate the fault with the following values:

0x78h = 40
0x79h = 18 40
0x80h = 04 or 44 or 40

SCP

If a short circuit condition occurs to the 48V main output, the 48V main output will shut down and latch off. The 5V V_{SB} will remain ON. The power LED will be solid green and the fail LED will be blinking amber. The PMBus™ registers will indicate the fault with the following values:

0x78h = 40
0x79h = 18 40
0x80h = 20

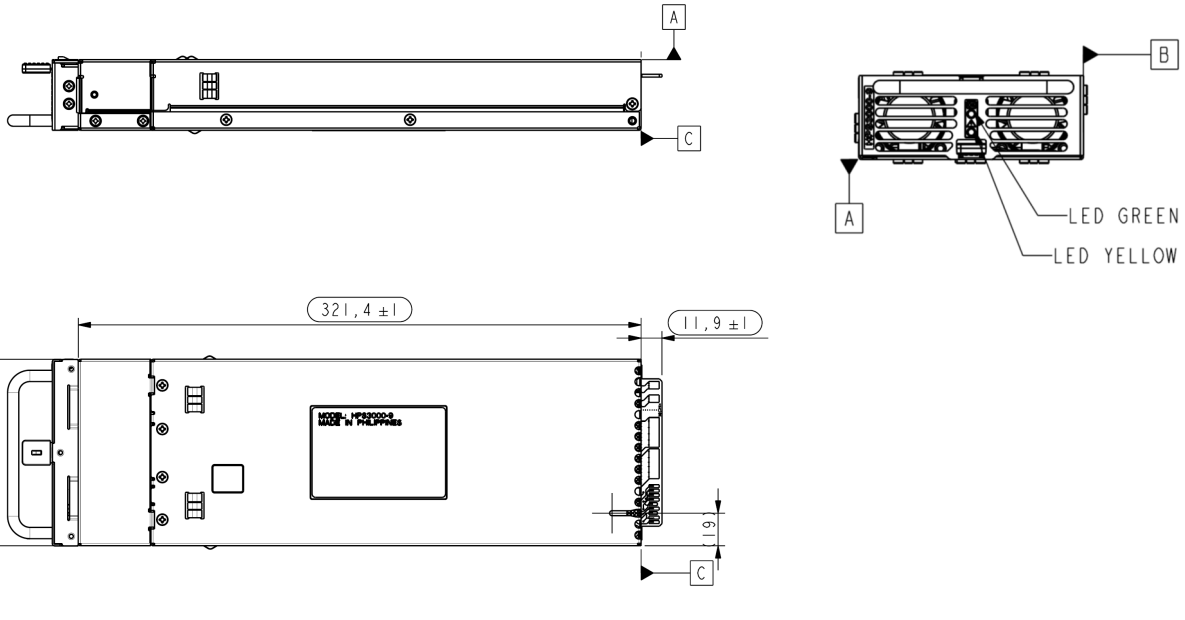
When the short circuit is removed, the power supply can be restarted by AC power or PSON# recycling.

If a short circuit condition occurs to the 5V V_{SB} output, the power supply will shut down with 48V main output turned off and the 5V V_{SB} current folded back to minimum (hiccup mode). The power supply (both 48V main output and 5V V_{SB}) will recover automatically when the fault condition cleared. While the fault condition exists, the power LED will be OFF and the fail LED will be solid amber. The PMBus™ registers will indicate the fault with the following values:

0x78h = 40
0x79h = 18 40
0x80h = 04 or 44 or 40

MECHANICAL SPECIFICATIONS

Mechanical Outlines (unit: mm)

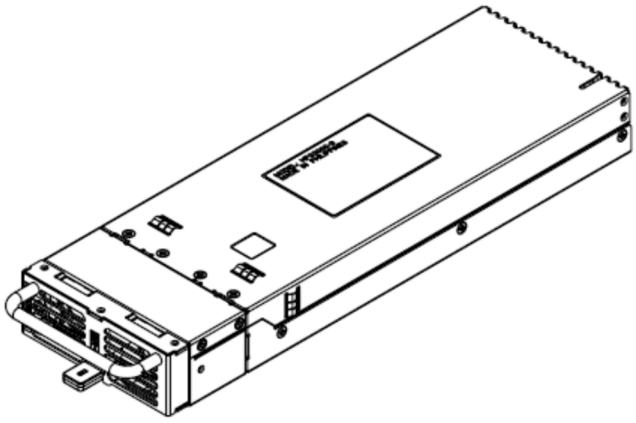


MECHANICAL SPECIFICATIONS

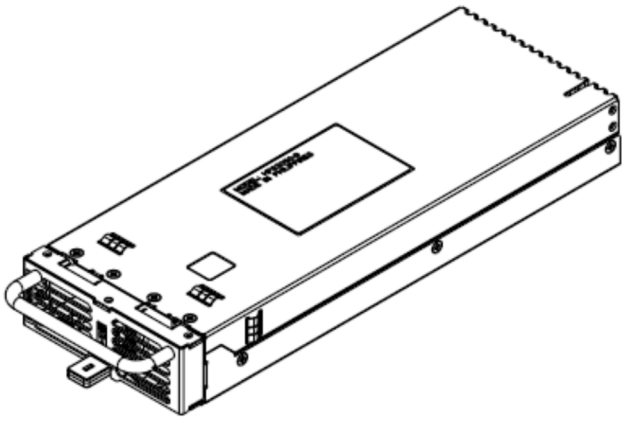
Mechanical Outlines (unit: mm)

3D VIEWS

HPS3000-9

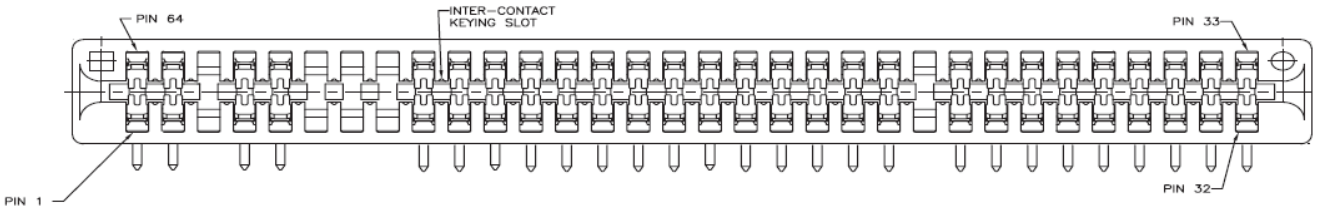


HPS3000NF-9



MECHANICAL SPECIFICATIONS

Connector Definitions



View into mating connector

Bottom side (left to right)		Top side (left to right)	
Pin	Definition	Pin	Definition
1	AC LINE	64	AC LINE
2	AC LINE	63	AC LINE
3	n.c.	62	n.c.
4	AC NEUTRAL	61	AC NEUTRAL
5	AC NEUTRAL	60	AC NEUTRAL
6	n.c.	59	n.c.
7	n.c.	58	n.c.
8	n.c.	57	n.c.
9	+48Vdc out (V_O)	56	+48Vdc out (V_O)
10	+48Vdc out (V_O)	55	+48Vdc out (V_O)
11	+48Vdc out (V_O)	54	+48Vdc out (V_O)
12	+48Vdc out (V_O)	53	+48Vdc out (V_O)
13	+48Vdc out (V_O)	52	+48Vdc out (V_O)
14	+48Vdc out (V_O)	51	+48Vdc out (V_O)
15	+48Vdc out (V_O)	50	+48Vdc out (V_O)
16	+48Vdc RTN	49	+48Vdc RTN
17	+48Vdc RTN	48	+48Vdc RTN
18	+48Vdc RTN	47	+48Vdc RTN
19	+48Vdc RTN	46	+48Vdc RTN
20	+48Vdc RTN	45	+48Vdc RTN
21	+48Vdc RTN	44	+48Vdc RTN
22	+48Vdc RTN	43	+48Vdc RTN
23	n.c.	42	n.c.
24	V_STBY (V_{SB})	41	STB RTN
25	Reserved	40	Reserved
26	PRESENT#	39	ACOK#
27	DCOK/PWOK#	38	SMBUS_ALERT_OUT
28	SDA	37	SCL
29	HVCC	36	A2
30	PSON#	35	PSKILL
31	#ALERT	34	A1
32	ISHARE	33	A0

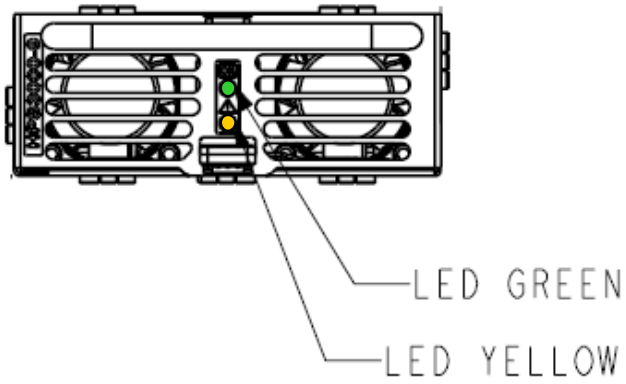
MECHANICAL SPECIFICATIONS

Mating Connection Specifications

Table 5. Mating Connectors for HPS3000 Series	
Vendor	Mating Connector or Equivalent
Tyco	2007209-1
FCI	10053363-200LF

MECHANICAL SPECIFICATIONS

LED Indicator Definitions



A green POWER LED (PWR) to indicate that AC is applied to the PSU and standby voltage is available when blinking. This same LED should go solid when the 48V output is enabled and operational.

An Amber Power Supply Fail LED (FAIL) to indicate that the power supply has failed and a replacement of the unit is necessary. Faults including UVP, OVP, OTP, or Fan Fail when PSON# is asserted, “Logic Low” shall cause the amber LED to turn on. The LED can be turned off by recycling PSON# signal or by an AC power interruption more than 1 second.

The LED shall be off when PSON# is not asserted “Logic Low”. Refer to below table for conditions of the LED’s:

Conditions	LED Conditions	
	Power LED	Fail LED
No AC power to PSU	OFF	OFF
AC present / Standby output ON	Blinking Green	OFF
Power supply DC output ON and OK	Green	OFF
Power supply failure (includes over voltage, over temperature)	OFF	Amber
Over current protection - Main	Green	Blinking Amber
Over current protection - V_{SB}	OFF	Amber

MECHANICAL SPECIFICATIONS

Weight

The HPS3000 series weight is 4.85 lbs (2.20 kg) maximum.

ENVIRONMENTAL SPECIFICATIONS

EMC Immunity

HPS3000 series power supply is designed to meet the following EMC immunity specifications:

Table 6. Environmental Specifications

Document	Description
FCC Part 15 Subpart B	
CISPR22/EN55032	
EN61000-3-2	Harmonics
EN61000-3-3	Voltage Fluctuations
IEC/EN61000-4-2	Electromagnetic Compatibility (EMC) - Testing and measurement techniques - Electrostatic discharge immunity test: +/-15KV air, +/-8KV contact discharge. Performance - Criteria B
EN61000-4-3 Radiated Susceptibility	80 - 1000Mhz, 10V/m, AM 80% (1KHz), 900MHz, 10V/M, PM 100% (200Hz), Performance - Criteria A
IEC/EN61000-4-4	Electromagnetic Compatibility (EMC) - Testing and measurement techniques - Electrical fast transient/burst immunity test: 2KV for AC power port. Performance - Criteria B 1KV for DC ports, I/O and signal ports. Performance - Criteria B
IEC/EN61000-4-5	Electromagnetic Compatibility (EMC) - Testing and measurement Techniques: Surge AC - 2KV common mode and 1KV differential mode for AC ports and 0.5KV differential mode for DC power, I/O and signal ports Performance - Criteria B
IEC/EN61000-4-11	Electromagnetic Compatibility (EMC) - Testing and measurement techniques - Voltage dips and interruptions: >30% reduction for 500ms, Criteria B; >95% reduction for 10ms, Criteria A >95% reduction for 500ms, Criteria C
EN55024:1998	Information Technology Equipment - Immunity characteristics, Limits and method of measurements
EN61000-4-3 Conducted Susceptibility	0.15 - 80Mhz, 10V/m, AM 80% (1KHz), Criteria A

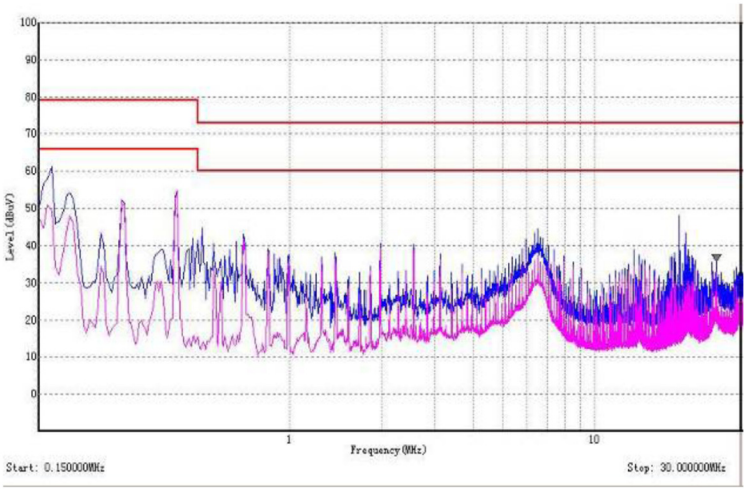
ENVIRONMENTAL SPECIFICATIONS

EMI Emissions

The HPS3000 series has been designed to comply with the Class A limits of EMI requirements of EN55032 (FCC Part 15) and Class A limits CISPR 22 (EN55032) for emissions and relevant sections of EN61000 (IEC61000) for immunity. The unit is enclosed inside a metal box, tested at 3000W using resistive load with cooling fan.

Conducted Emissions

The applicable standard for conducted emissions is EN55032 (FCC Part 15). Conducted noise can appear as both differential mode and common mode noise currents. Differential mode noise is measured between the two input lines, with the major components occurring at the supply fundamental switching frequency and its harmonics. Common mode noise, a contributor to both radiated emissions and input conducted emissions, is measured between the input lines and system ground and can be broadband in nature.



The HPS3000 series power supply has internal EMI filters to ensure the convertor's conducted EMI levels comply with EN55032 (FCC Part 15) Class A limits and EN55032 (CISPR 22) Class A limits. The EMI measurements are performed with resistive loads at maximum rated loading.

Sample of EN55032 conducted EMI measurement at 100Vac input.

Note: Upper red line refers to Emerson Quasi Peak which is 6dB below the CISPR international limit. Lower red line refers to the Emerson Average which is 6dB below the CISPR international limit.

Table 7. Conducted EMI Emission Specifications of The HPS3000 Series Power Supply

Parameter	Model	Symbol	Min	Typ	Max	Unit
FCC 47 Part 15, class A	All	Margin	-	-	6	dB
CISPR 22 (EN55032), class A	All	Margin	-	-	6	dB

Radiated Emissions

Unlike conducted EMI, radiated EMI performance in a system environment may differ drastically from that in a stand-alone power supply. The shielding effect provided by the system enclosure may bring the EMI level from Class A to Class B. It is thus recommended that radiated EMI be evaluated in a system environment. The applicable standard is EN55032 Class A (FCC Part 15). Testing ac-dc convertors as a stand-alone component to the exact requirements of EN55032 can be difficult, because the standard calls for 1m leads to be attached to the input and outputs and aligned such as to maximize the disturbance. In such a set-up, it is possible to form a perfect dipole antenna that very few ac-dc convertors could pass. However, the standard also states that "an attempt should be made to maximize the disturbance consistent with the typical application by varying the configuration of the test sample".

ENVIRONMENTAL SPECIFICATIONS

Safety Certifications

The HPS3000 series power supply is intended for inclusion in other equipment and the installer must ensure that it is in compliance with all the requirements of the end application. This product is only for inclusion by professional installers within other equipment and must not be operated as a stand alone product.

Table 8. Safety Certifications for HPS3000 Series Power Supply

Document	File #	Description
UL62368-1	E186249-A6023-UL-X10	US and Canada Requirements
CSA 22.2 No. 62368-1	E186249-A6023-UL-X10	
EN62368-1	D-07498	European Requirements
IEC62368-1 Deviations (CB scheme)	DK-87776-UL	International Requirements
CHINA CCC Approval	A2009CCC0907-842730	China Requirements
UKCA Mark		UK Requirements

ENVIRONMENTAL SPECIFICATIONS

Operating Temperature

The HPS3000 power supply can start and operate within stated specifications at an ambient temperature from -10°C to 40°C under all load conditions with internal fan.

Forced Air Cooling

The fan(s) will be included as part of the power supply assembly and provide forced air-cooling of desired CFM to maintain or control temperature of devices and ambient temperature in the power supply to appropriate levels.

ENVIRONMENTAL SPECIFICATIONS

Storage and Shipping Temperature

The HPS3000 series power supply can be stored or shipped at temperatures between -40°C to +85°C and relative humidity from 5% to 95% non-condensing.

Altitude

The HPS3000 series will operate within specifications at altitudes up to 10000 feet above sea level. The power supply shall not be damaged when stored at altitudes of up to 30000 feet above sea level.

Humidity

The HPS3000 series will operate within specifications when subjected to a relative humidity from 20% to 90% non-condensing. The HPS3000 series can be stored in a relative humidity from 10% to 95% non-condensing.

Vibration

The HPS3000 power supply will pass the following vibration specifications:

Non-Operating Sine Vibration

Acceleration	5	gRMS
Frequency Range	5 - 500	Hz
Duration	60	mins
Direction	3 mutually perpendicular axis	

Non-Operating Random Vibration

Acceleration	2.7		gRMS
Frequency Range	10 - 2000		Hz
Duration	20		mins
Direction	3 mutually perpendicular axis		
PSD Profile	**FREQ (Hz)**	**SLOPE (db/oct)**	**PSD (g^2/Hz)**
	10 - 190	/	0.001
	190 - 210	-31.213	/
	210 - 2000	/	0.003

ENVIRONMENTAL SPECIFICATIONS

Operating Random Vibration

Acceleration	1.0		gRMS
Frequency Range	10 - 500		Hz
Duration	20		mins
Direction	3 mutually perpendicular axis		
PSD Profile	**FREQ (Hz)**	**SLOPE (db/oct)**	**PSD (g^2/Hz)**
	10 - 500	/	0.002

Shock

The HPS3000 power supply will pass the following vibration specifications:

Non-Operating Half-Sine Shock

Acceleration	30	G
Duration	18	mSec
Pulse	Half-sine	
Number of Shock	3 shocks on each of 6 faces	

Operating Half-Sine Shock

Acceleration	4	G
Duration	22	mSec
Pulse	Half-sine	
Number of Shock	3 shocks on each of 6 faces	

POWER AND CONTROL SIGNAL DESCRIPTIONS

AC Input Connector

AC Mains is supplied to the HPS3000 power supply from the following pins of the mating connector.

Pin 1, 2, 63, 64 – AC Line
Pin 4, 5, 60, 61 – AC Neutral

Output Connector – Main Output

These pins provide the main output for the HPS3000 series power supply. The Main Output (V_O) and the Main Output Return pins are the positive and negative rails, respectively, of the V_O main output of the HPS3000 series power supply. The Main Output (V_O) is electrically isolated from the power supply chassis.

Pin 9 to 15 and Pin 50 to 56 – +48Vdc out (V_O)
Pin 16 to 22 and Pin 43 to 49 – +48Vdc RTN

Output Connector – Control Signals

The HPS3000 series power supply contains 18 control signals providing analogy control interface, standby power and I^2C interface.

V_STBY, V_STBY GND - (Pin 24, Pin 41)

The HPS3000 provides a regulated 5 volt 3 amp standby output voltage to power critical circuitry that must remain active regardless of the on/off status of the power supply's main output. The V_STBY (VSB) voltage is available whenever a valid AC input voltage is applied to the unit. The V_STBY output (Pin 24) is referenced to the V_STBY GND pins (Pin 41).

PRESENT# - (Pin 26)

The PRESENT# signal is primarily used to provide a mechanism by which the host system can sense the number of power supplies physically present (operational or not). This signal pin is connected to Main Output Return inside the power supply. This pin is to be pull high on the system side by a resistor of 4.7K or higher. A logic LOW indicates the power supply is inserted and seated into the system power supply connector. A Logic HIGH indicated the removal of the power supply.

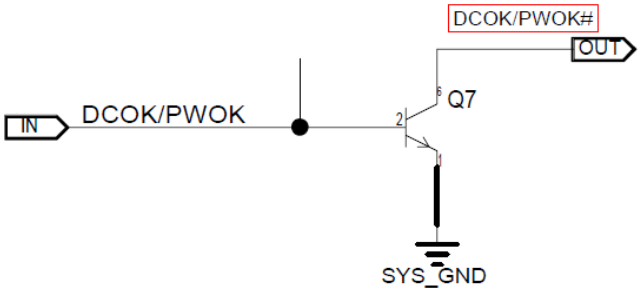
DCOK/PWOK# - (Pin 27)

PWOK# is a power good signal and will be pulled LOW by the power supply to indicate that both the main and standby outputs are valid. When any output voltage falls below its regulation limits or when AC power has been removed for a time sufficiently long so that power supply operation is no longer guaranteed, PWOK will be de-asserted to a HIGH state. The start of the PWOK# delay time shall be inhibited as long as the +48Vdc output is in current limit or the $5V_{SB}$ output is below the regulation limit.

Table 9. PWOK# Signal Characteristic

Signal Type	Pull-up to $5V_{SB}$ through a resistor in the host system	
PWOK# = Low	Power Good	
PWOK# = High	Power not Good	
	MIN	MAX
Logic level low voltage, sink current = 4mA	0V	0.4V
Logic level high voltage, source current = 20uA	2V	5.25V
Sink current, PWOK# = low	-	4mA
Source current, PWOK# = high	-	0uA
PWOK# rise and fall time	-	100us

POWER AND CONTROL SIGNAL DESCRIPTIONS



HVCC - (Pin 29)

The HVCC line should be tied together on units in parallel. This is the maintain the housekeeping power to those units that are plugged in to the system backplane but AC power is removed.

PSON# - (Pin 30)

The PSON# signal is required to remotely turn on/off the power supply. PSON# is an active low signal that turns on the +48Vdc power rail when this signal is pulled low, below 0.8V. When this signal is driven higher than 2.4V, or left open circuited, the +48Vdc output will be disabled (the V_{SB} output remains on and the power supply fans operate at the lowest speed). This signal is pulled to a 3.3V standby voltage by a 4.7Kohm pull-up resistor internal to the power supply.

Table 10. PSON# Signal Characteristic

Signal Type	Pull-up to $5V_{SB}$ through a resistor internal to the power supply	
PSON# = Low	ON	
PSON# = Open	OFF	
	MIN	MAX
Logic level low voltage (Power supply ON)	0V	0.8V
Logic level high voltage (Power supply OFF)	2.4V	3.4V
Source current, PSON# = Low	-	1mA

#ALERT - (Pin 31)

See Communication Bus Description

ISHARE - (Pin 32)

The HPS3000's main 48Vdc output supports active current sharing through a single wire connection between the power supplies. This input/output signal pin allows two or more power supplies to share the main output load current to increase the overall power capability or to operate the units in a N+1 configuration for redundancy purposes. When two or more power supplies are connected and operating in parallel and each is delivering 20-100% of its rated output to the load, the power supplies will current share within 10% accuracy (Below 10% load, there is no guarantee of output current sharing). If any power supply is hot swapped, no glitch will occur that violates the regulation limits of the power supply defined in this specification.

POWER AND CONTROL SIGNAL DESCRIPTIONS

A0, A1, A2 - (Pin 33, Pin 34, Pin 36)

Please refer to “Communication Bus Descriptions” section.

PS_KILL - (Pin 35)

This signal pin should be grounded in the system. If left open, power supply operation will be inhibited (standby VSB output will remain on).

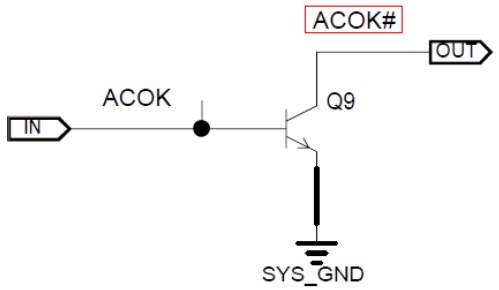
SCL - (Pin 37)

Please refer to “Communication Bus Descriptions” section.

ACOK# - (Pin 39)

The ACOK# signal is used to indicate presence of AC input to the power supply. A logic LOW level indicate when the AC input voltage is within the allowable limits. A Logic HIGH on this signal shall indicate a loss of AC input to the power supply.

Table 11. ACOK# Signal Characteristic		
Signal Type	**Pull-up to $5V_{SB}$ through a resistor in the host system**	
ACOK# = Low	Present	
ACOK# = High	Not Present	
	MIN	MAX
Logic level low voltage, sink current = 4mA	0V	0.4V
Logic level high voltage, sink current = 50uA	2V	5.25V
Sink current, PRESENT# = Low	-	4mA
Sink current, PRESENT# = High	-	50uA



COMMUNICATION BUS DESCRIPTIONS

I²C Bus Signals

The HPS3000 series power supply contains enhanced monitor and control functions implemented via the I²C bus. The HPS3000 series I²C functionality (PMBus™ and FRU data) can be accessed via the output connector control signals. The communication bus is powered either by the internal 5V supply or from an external power source connected to the standby output (i.e. accessing an unpowered power supply as long as the standby output of another power supply connected in parallel is on).

If units are connected in parallel or in redundant mode, the standby outputs must be connected together in the system. Otherwise, the I²C bus will not work properly when a unit is inserted into the system without the DC source connected.

Note: PMBus™ functionality can be accessed only when the PSU is powered-up. Guaranteed communication I²C speed is 100KHz.

SDA, SCL (I²C Data and Clock Signals) - (Pins 28, 37)

I²C serial data and clock bus - these pins are internally pulled up to internal 5V supply with a 10Kohm resistor. These pins must be pulled-up in the system by an 1Kohm resistor to the standby output.

#ALERT - (Pin 31)

#ALERT is used to send a signal to the system that a fault in the power supply occurred. This signal is normally logic level HIGH. It will go to a LOW logic level when a fault bit has been set in the power supply's status register. To reset the #ALERT signal back to normal (logic HIGH level), perform one of the following actions - (1) recycle input AC power, (2) toggle PSON signal and (3) issuance of a CLEAR_FAULTS PMBus™ command.

A0, A1, A2 (I²C Address BIT 0, BIT1, BIT2 Signals) - (Pins 33, 34, 36)

These two input pins are the address lines A0 and A1 to indicate the slot position the power supply occupies in the power bay and define the power supply addresses for FRU data and PMBus™ data communication. This allows the system to assign different addresses for each power supply. During I²C communication between system and power supplies, the system will be the master and power supplies will be slave. They are internally pulled up to internal 5V supply with a 5Kohm resistor. A2 is pulled to standby output return internally in the power supply, not available as external address.

I²C Bus Communication Interval

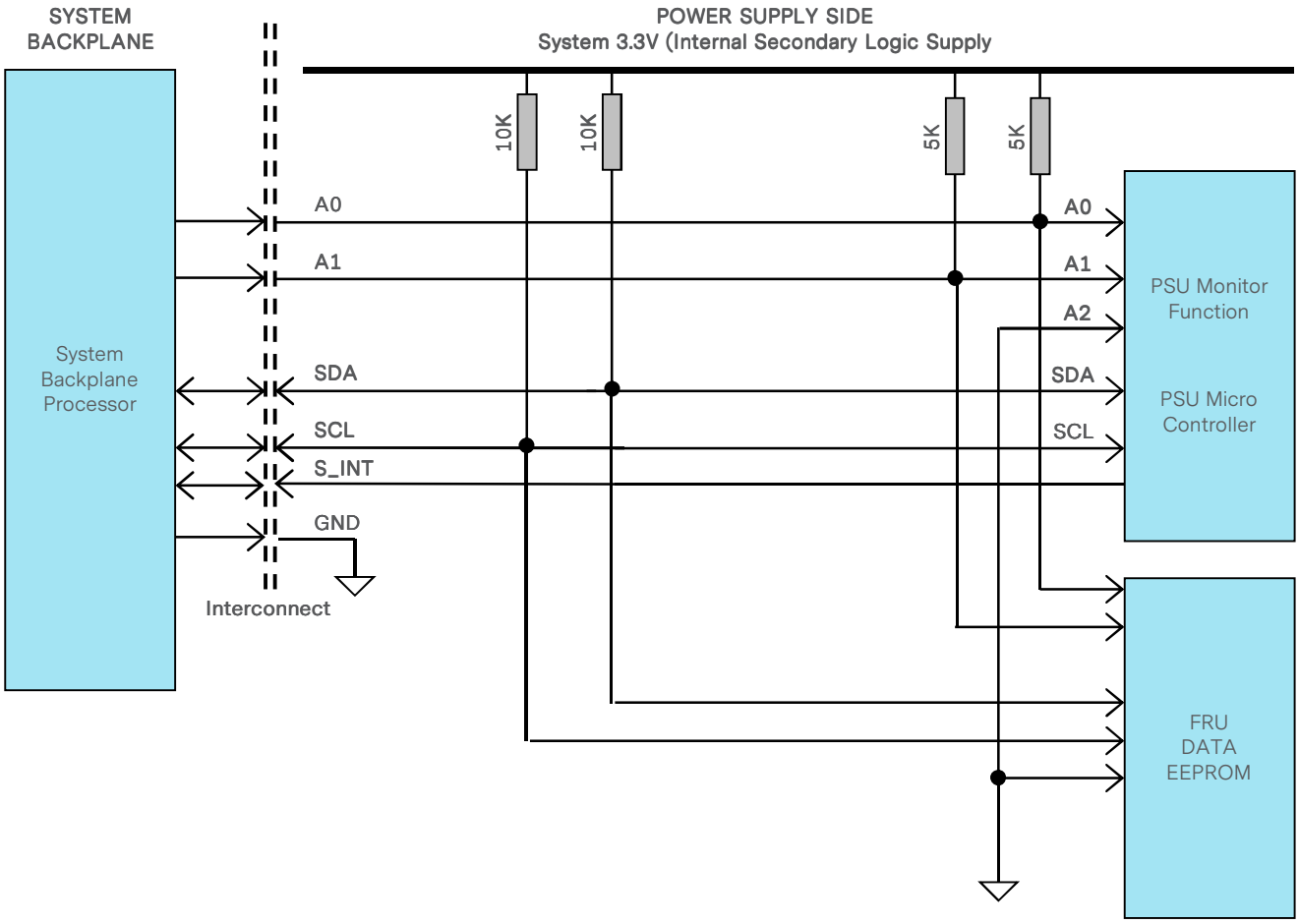
The interval between two consecutive I²C communications to the power supply must be at least 50ms to ensure proper monitoring functionality.

I²C Bus Signal Integrity

The noise on the I²C bus (SDA, SCL lines) due to the power supply will be less than 500mV peak-to-peak. This noise measurement should be made with an oscilloscope bandwidth limited to 100MHz. Measurements should be make at the power supply output connector with 3.2Kohm resistors pulled up to standby output and 20pf ceramic capacitors to standby output return. The noise on the address lines A0 and A1 will be less than 100mV peak-to-peak. This noise measurement should be made at the power supply output connector.

COMMUNICATION BUS DESCRIPTIONS

I²C Bus Internal Implementation, Pull-ups and Bus Capacitances



I²C Bus - Recommended external pull-ups

Electrical and interface specifications of I²C signals (referenced to standby output return pin, unless otherwise indicated):

Parameter	Condition	Symbol	Min	Type	Max	Unit
SDA, SCL Internal Pull-up Resistor		R_{int}	-	10.0	-	Kohm
SDA, SCL Internal Bus Capacitance		C_{int}	-	0	-	pF
Recommended External Pull-up Resistor	1 PSU	R_{ext}	-	10.0	-	Kohm
	4 PSU	R_{ext}	-	2.5	-	Kohm

COMMUNICATION BUS DESCRIPTIONS

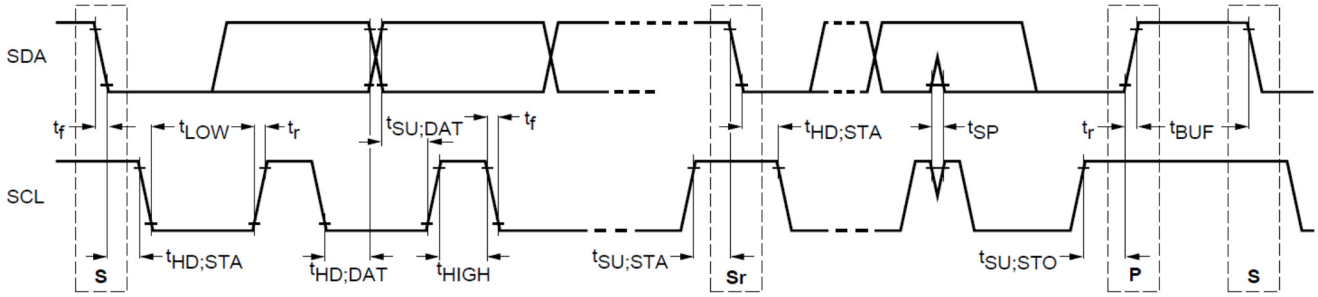
Logic Levels

HPS3000 series power supply I²C communication bus will respond to logic levels as per below:

Logic High: 3.3V nominal (Spec is 2.1V to 5.5V)**
Logic Low: 500mV nominal (Spec is 800mV max)**

**Note: Artesyn 73-769-001 I²C adapter was used.

Timings



Parameter	Symbol	Standard-Mode Specs		Actual Measured		Unit
		Min	Max			
SCL clock frequency	f_{SCL}	0	100	90.1		KHz
Hold time (repeated) START condition	$t_{HD;STA}$	4.0	-	4.76		uS
LOW period of SCL clock	t_{LOW}	4.7	-	4.7		uS
HIGH period of SCL clock	t_{HIGH}	4.0	-	4.4		uS
Setup time for repeated START condition	$t_{SU;STA}$	4.7	-	5.2		uS
Data hold time	$t_{HD;DAT}$	0	3.45	1.2		uS
Data setup time	$t_{SU;DAT}$	250	-	3200		nS
Rise time	t_r	-	1000	SCL = 995	SDA = 998	nS
Fall time	t_f	-	300	SCL = 160	SDA = 146	nS
Setup time for STOP condition	$t_{SU;STO}$	4.0	-	6.7		uS
Bus free time between a STOP and START condition	t_{BUF}	4.7	-	20		uS

COMMUNICATION BUS DESCRIPTIONS

Device Addressing

The HPS3000 series will respond to supported commands on the I²C bus that are addressed according to pins A2, A1 and A0 pins of output connector.

Address pins are held HIGH by default via pulled up to internal 5V supply with a 5Kohm resistor. To set the address as “0”, the corresponding address line should be pulled down to logic ground level. Below tables show the address of the power supply with A0, A1 and A2 pins set to either “0” or “1”.

The I²C address of the device is based on the slot the PSU is in. The address is defined as follows:

PSU Slot	Slot ID Bits			PMBus™ Address	EEPROM (FRU) Address
	A2[1]	A1	A0		
1	0	0	0	0xB0	0xA0
2	0	0	1	0xB2	0xA2
3	0	1	0	0xB4	0xA4
4	0	1	1	0xB6[2]	0xA6

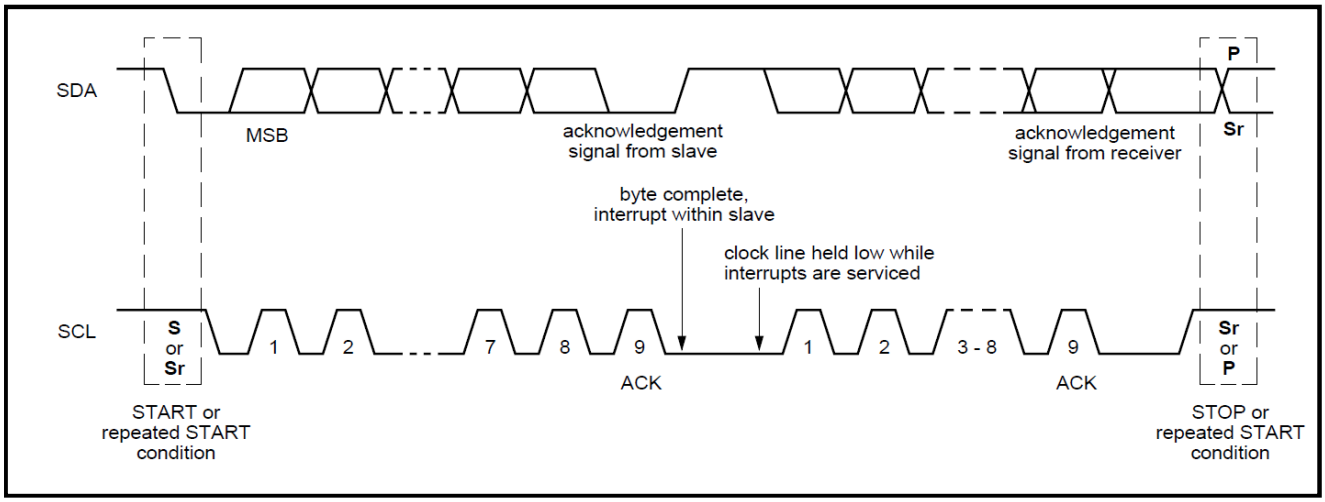
Note 1: A2 is pulled LOW internally in the power supply.
Note 2: It is the default EEPROM address when A0 and A1 are left open.

COMMUNICATION BUS DESCRIPTIONS

I²C Clock Synchronization

The HPS3000 series power supply applies clock stretching. An addressed slave power supply holds the clock line (SCL) low after receiving (or sending) a byte, indicating that it is not yet ready to process more data. The system master that is communicating with the power supply will attempt to raise the clock to transfer the next bit but must verify that the clock line was actually raised. If the power supply is clock stretching, the clock line will still be low (because the connections are open-drain).

The maximum time-out condition for clock stretching for HPS3000 series is 100 milliseconds.



COMMUNICATION BUS DESCRIPTIONS

FRU (EEPROM) Data

The FRU (Field Replaceable Unit) data format is compliant with the Intel IPMI v1.2 specification.

The HPS3000 series uses 1 page of EEPROM for FRU purpose. A page of EEPROM contains up to 256 byte-sized data locations.

Where:
- OFFSET -The OFFSET denotes the address in decimal format of a particular data byte within HPS3000 series EEPROM.
- VALUE -The VALUE details data written to a particular memory location of the EEPROM.
- DEFINITION -The contents DEFINITION refers to the definition of a particular data byte.

HPS3000-9 FRU (EEPROM) Data:

OFFSET		DEFINITION	SPEC VALUE	
(DEC)	(HEX)	(REMARKS)	(DEC)	(HEX)
		COMMON HEADER, 8 BYTES		
0	00	**FORMAT VERSION NUMBER** (Common header)	1	01
1	01	**INTERNAL USE AREA OFFSET** (In multiples of 8 bytes)	24	18
2	02	**CHASSIS INFO AREA OFFSET** (In multiples of 8 bytes)	1	01
3	03	**BOARD INFO AREA OFFSET** (No used)	0	00
4	04	**PRODUCT INFO AREA OFFSET** (In multiples of 8 bytes)	5	05
5	05	**MULTI RECORD AREA OFFSET** (In multiples of 8 bytes)	15	0F
6	06	**PAD** (reserved always 00H)	0	00
7	07	**ZERO CHECK SUM** (256 - (Sum of bytes 000d to 006d))	210	D2
		CHASSIS INFO AREA (32 BYTES)		
8	08	**FORMAT VERSION NUMBER** (Default value is 1.)	1	01
9	09	**CHASSIS INFO AREA LENGTH** (Default value is 0.)	0	00
10	0A	**CHASSIS TYPE** (Default value is 0.)	0	00
11	0B	**CHASSIS PART NUMBER Type/Length 10 Bytes allocation**	0	00
12	0C	**CHASSIS PART NUMBER BYTES** (Default value is 0.)	0	00
13	0D		0	00
14	0E		0	00
15	0F		0	00
16	10		0	00
17	11		0	00
18	12		0	00
19	13		0	00
20	14		0	00
21	15		0	00
22	16	**CHASSIS Type/Length 15 Bytes allocation 0CFH** (If used) (Default value is 0.)	0	00
23	17	**CHASSIS SERIAL NUMBER BYTES** (Default value is 0.)	0	00
24	18		0	00
25	19		0	00
26	1A		0	00
27	1B		0	00
28	1C		0	00
29	1D		0	00
30	1E		0	00
31	1F		0	00
32	20		0	00
33	21		0	00
34	22		0	00
35	23		0	00
36	24		0	00
37	25		0	00

COMMUNICATION BUS DESCRIPTIONS

HPS3000-9 FRU (EEPROM) Data:

OFFSET		DEFINITION	SPEC VALUE	
(DEC)	(HEX)	(REMARKS)	(DEC)	(HEX)
38	26	**End Tag** (0C1h if used) (Default value is 0.)	0	00
39	27	**ZERO CHECK SUM** (From 08d to 38d if used)	255	FF
		COMPUTER/CHASSIS INFO AREA (32 BYTES)		
40	28	**FORMAT VERSION NUMBER**	1	01
41	29	**PRODUCT INFO AREA LENGTH** (In multiples of 8 bytes) 80 bytes are allocated. 80-bytes / 8 = 0AH.	10	0A
42	2A	**Language** (English = 19H)	25	19
43	2B	**MANUFACTURER NAME TYPE / LENGTH** (0C5H) 7-6: (11)b, 8-bit ASCII + Latin 1, 5-0: (000101)b, 5-byte allocation	197	C5
 44 45 46 47 48	 2C 2D 2E 2F 30	**MANUFACTURER'S NAME** 5 bytes sequence “E” “N” “P” “ ” “ ”	 69 78 80 32 32	 45 4E 50 20 20
49	31	**PRODUCT NAME** Type/Length (0CEH) 7-6: (11)b, 8-Bit ASCII + Latin 1, 5-0: (001110)b, 14-Byte Allocation	206	CE
50 51 52 53 54 55 56 57 58 59 60 61 62 63	32 33 34 35 36 37 38 39 3A 3B 3C 3D 3E 3F	**PRODUCT NAME** “H” “P” “S” “3” “0” “0” “0” “-” “9”	72 80 83 51 48 48 48 45 57 0 0 0 0 0	48 50 53 33 30 30 30 2D 39 00 00 00 00 00
64	40	**PART/MODEL NUMBER Type/Length (0CAH)** 7-6: (11)b, 8-bit ASCII + Latin 1, 5-0: (001000)b, 8-byte allocation	200	C8
65 66 67 68 69 70 71 72	41 42 43 44 45 46 47 48	**Power Supply Spare Kit Number** NOT APPLICABLE	0 0 0 0 0 0 0 0	00 00 00 00 00 00 00 00
73	49	**Product Version Number Type/Length (0C2H)** 7-6: (11)b, 8-bit ASCII + Latin 1, 5-0: (000010)b, 2-byte allocation	194	C2
74 75	4A 4B	**Product Version Number / Auto Rev** *SHOULD TRACK MODEL REVISION on IPS Sec. 1.2	XXX XXX	XX XX
76	4C	**Product Serial Number Type/Length (0CDH)** *PRODUCT SERIAL NUMBER IS BASED ON ASTEC SERIAL NUMBER FORMAT P/N: 417-00201000 7-6: (11)b, 8-bit ASCII + Latin 1, 5-0: (001101)b, 13-byte allocation	205	CD

COMMUNICATION BUS DESCRIPTIONS

HPS3000-9 FRU (EEPROM) Data:

OFFSET		DEFINITION	SPEC VALUE	
(DEC)	(HEX)	(REMARKS)	(DEC)	(HEX)
		Product Serial Number: MODEL ID		
77	4D	"H"	72	48
78	4E	"0"	48	30
79	4F	"8"	56	38
80	50	"1"	49	31
81	51	**MANUFACTURING YEAR AND WEEK CODE**	XXX	XX
82	52	**Product Serial Number:** MANUFACTURING YEAR AND WEEK CODE *REFER TO 417-00201000 FOR DETAILS	XXX	XX
83	53	**Product Serial Number:** UNIQUE SERIAL NUMBER	XXX	XX
84	54	*REFER TO 417-00201000 FOR DETAILS	XXX	XX
85	55		XXX	XX
86	56		XXX	XX
87	57	**Product Serial Number:** MODEL REVISION	XXX	XX
88	58	***SHOULD TRACK MODEL REVISION on IPS Sec. 1.2**	XXX	XX
Product Serial Number: MANUFACTURING LOCATION *REFER TO 417-00201000 FOR DETAILS				
89	59	"P" (P for Laguna Philippines)	80	50
90	5A	**ASSET TAG** 7-6: (11)b, 8-bit ASCII + Latin 1, 5-0: (001000)b, 8-byte allocation	200	C8
91	5B	**NO ASSET TAG**	0	00
92	5C		0	00
93	5D		0	00
94	5E		0	00
95	5F		0	00
96	60		0	00
97	61		0	00
98	62		0	00
99	63	**FRU File ID** 7-6: (11)b, 8-bit ASCII + Latin 1, 5-0: (010001)b, 17-byte allocation	209	D1
100	64	**"Should track latest EEPROM Revision on IPS Sec. 1.2"**	0	00
101	65	**NOT APPLICABLE**	0	00
102	66		0	00
103	67		0	00
104	68		0	00
105	69		0	00
106	6A		0	00
107	6B		0	00
108	6C		0	00
109	6D		0	00
110	6E		0	00
111	6F		0	00
112	70		0	00
113	71		0	00
114	72		0	00
115	73		0	00
116	74		0	00
117	75	**End of Fields Marker**	193	C1
118	76	**RESERVED**	0	00
119	77	**Zero Checksum From 040d to 118d**	XXX	XX
MULTI RECORD AREA: Power Supply Information 72 Bytes				
Power Supply Record Header				
120	78	**Record Type ID** (0x00 = Power Supply Information)	0	00

COMMUNICATION BUS DESCRIPTIONS

HPS3000-9 FRU (EEPROM) Data:

OFFSET		DEFINITION	SPEC VALUE	
(DEC)	(HEX)	(REMARKS)	(DEC)	(HEX)
121	79	7: (0)b, End of List 6-4: (000)b, Reserved 3-0: (0010)b, Record Format Version	2	02
122	7A	**Record Length: 24 Bytes**	24	18
123	7B	**Record Checksum (Zero Checksum From 125d To 148d)**	100	64
124	7C	**Header Checksum (Zero Checksum From 120d To 123d)**	13	82
POWER SUPPLY RECORD				
125 126	7D 7E	**Overall Capacity** (Watts) 15-12: (0000)b, reserved 11-0: (11111010000)b, 3000W Stored with LSB first then MSB.	184 11	B8 0B
127 128	7F 80	**Peak VA** (Watts) 15-12: (0000)b, reserved 11-0: No peak VA rating Stored with LSB first then MSB	0 0	00 00
129	81	**Inrush Current** (Amps) 40Amps	40	28
130	82	**Inrush Interval** (ms) 0ms	0	00
131 132	83 84	**Low End Input Voltage Range 1**	0 0	00 00
133 134	85 86	**High End Input Voltage Range 1**	0 0	00 00
135 136	87 88	**Low End Input Voltage Range 2** 180V = 18000 (x10mV) Stored with LSB first then MSB.	80 70	50 46
137 138	89 8A	**High End Input Voltage Range 2** 264V = 26400 (x10mV) Stored with LSB first then MSB.	32 103	20 67
139	8B	**Low End Input Frequency Range, 47Hz**	47	2F
140	8C	**High End Input Frequency Range, 63Hz**	63	3F
141	8D	**A/C Dropout Tolerance in ms, 12ms**	12	0C
142	8E	**Binary Flags** 7-5: (000)b, reserved 4: (1)b, Tachometer Pulses Per Rotation / Predictive Fail Polarity (2 Pulses Per Rotation = 1; 1 Pulse Per Rotation = 0) OR (Signal Asserted(1) Indicates Failure = 0, Signal Deasserted(0) Indicates Failure = 1) 3: (1)b, Hot Swap / Redundancy Support 2: (0)b, AutoSwitch Support 1: (1)b, Power Factor Correction Support 0: (0)b, Predictive Fail Support	26	1A
143 144	8F 90	**Peak Wattage Capacity and Holdup Time** 15-12: (0000)b, Hold Up Time in Seconds = 00H (Not Specified) 11-0: (000000000000)b, Peak Capacity in Watts = 00H (Not Specified)	0 0	00 00
145 146 147	91 92 93	**Combined Wattage** **NOT APPLICABLE**	0 0 0	00 00 00
148	94	**Predictive Fail Tachometer Lower Threshold, Not applicable**	0	00
48V DC Output Record Header				
149	95	Record Type ID (0x01 = DC Output)	001	01

COMMUNICATION BUS DESCRIPTIONS

HPS3000-9 FRU (EEPROM) Data:

OFFSET		DEFINITION	SPEC VALUE	
(DEC)	(HEX)	(REMARKS)	(DEC)	(HEX)
150	96	**End Of List / Record Format Version Number** 7: (0)b, End of List 6-4: (000)b, Reserved 3-0: (0010)b, Record Format Version	002	02
151	97	**Record Length: 13 bytes**	013	0D
152	98	**Record Checksum** (Zero checksum from 154d to 166d)	194	C2
153	99	**Header Checksum** (Zero checksum from 149d to 152d	46	2E
		+48V DC OUTPUT RECORD		
154	9A	**48V Output Information** 7: (0)b, Standby 6-4: (000)b, Reserved 3-0: (0001)b, Output Number 1	001	01
155 156	9B 9C	**Nominal Voltage** 48V = 4800 (x10mV) Stored with LSB first then MSB.	192 018	C0 12
157 158	9D 9E	**Maximum Negative Voltage Deviation** 43.2V = 4320 (x10mV) Stored with LSB first then MSB.	224 016	E0 10
159 160	9F A0	**Maximum Positive Voltage Deviation** 52.8V = 5280 (x10mV) Stored with LSB first then MSB.	160 020	A0 14
161 162	A1 A2	**Ripple And Noise pk -pk 10Hz To 30MHz (mV)** 480mV Stored with LSB first then MSB.	224 001	E0 01
163 164	A3 A4	**Minimum Current Draw (10mA)** 1A = 100 (x10mA) Stored with LSB first then MSB.	100 000	64 00
165 166	A5 A6	**Maximum Current Draw (10mA)** 62.50A = 6250 (x10mA) Stored with LSB first then MSB.	106 024	6A 18
		5VSB OUTPUT RECORD HEADER		
167	A7	**Record Type ID** (0x01 = DC Output)	001	01
168	A8	**End Of List/Record Format Version Number** 7: (1)b, End of List 6-4: (000)b, Reserved 3-0: (0010)b, Record Format Version	130	82
169	A9	**Record Length: 20 bytes**	020	14
170	AA	**Record Checksum** (Zero checksum from 172d to 191d)	219	DB
171	AB	**Header Checksum** (Zero checksum from 167d to 170d)	142	8E
		5VSB DC OUTPUT RECORD		
172	AC	**5VSB Output Information** 7: (1)b, Standby (Bit = 1 to indicate standby output) 6-4: (000)b, Reserved 3-0: (0010)b, Output Number 2 = 010b	130	82
173 174	AD AE	**Nominal Voltage** 5V = 500 (x10mV) Stored with LSB first then MSB.	244 001	F4 01
175 176	AF B0	**Maximum Negative Voltage Deviation** 4.8V = 480 (x10mV) Stored with LSB first then MSB.	224 001	E0 01
177 178	B1 B2	**Maximum Positive Voltage Deviation** 5.2V = 520 (x10mV) Stored with LSB first then MSB.	008 002	08 02

COMMUNICATION BUS DESCRIPTIONS

HPS3000-9 FRU (EEPROM) Data:

OFFSET		DEFINITION	SPEC VALUE	
(DEC)	(HEX)	(REMARKS)	(DEC)	(HEX)
179 180	B3 B4	**Ripple And Noise pk-pk 10Hz To 30MHz** (mV) 100mV Stored with LSB first then MSB.	100 000	64 00
181 182	B5 B6	**Minimum Current Draw** (10mA) 0.5A = 50 (x10mA) Stored with LSB first then MSB.	050 000	32 00
183 184	B7 B8	**Maximum Current Draw** (10mA) 3.00A = 300 (x10mA) Stored with LSB first then MSB.	044 001	2C 01
185	B9	**Reserved**	000	00
186	BA	**Reserved**	000	00
187	BB	**Reserved**	000	00
188	BC	**Reserved**	000	00
189	BD	**Reserved**	000	00
190	BE	**Reserved**	000	00
191	BF	**Reserved**	000	00
INTERNATIONAL USE AREA, 64 BYTES				
192	C0	**Format Version Number** 7:4 - Reserved, write as 0000b 3:0 - Format Version Number = 1h for this specification.	001	01
193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224 225 226	C1 C2 C3 C4 C5 C6 C7 C8 C9 CA CB CC CD CE CF D0 D1 D2 D3 D4 D5 D6 D7 D8 D9 DA DB DC DD DE DF E0 E1 E2		0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00

COMMUNICATION BUS DESCRIPTIONS

HPS3000-9 FRU (EEPROM) Data:

OFFSET		DEFINITION	SPEC VALUE	
(DEC)	(HEX)	(REMARKS)	(DEC)	(HEX)
227	E3		0	00
228	E4		0	00
229	E5		0	00
230	E6		0	00
231	E7		0	00
232	E8		0	00
233	E9		0	00
234	EA		0	00
235	EB		0	00
236	EC		0	00
237	ED		0	00
238	EE		0	00
239	EF		0	00
240	F0		0	00
241	F1		0	00
242	F2		0	00
243	F3		0	00
244	F4		0	00
245	F5		0	00
246	F6		0	00
247	F7		0	00
248	F8		0	00
249	F9		0	00
250	FA		0	00
251	FB		0	00
252	FC		0	00
253	FD		0	00
254	FE		0	00
255	FF	**Zero CHECKSUM of Internal Use Area** (if used).	255	FF

COMMUNICATION BUS DESCRIPTIONS

FRU (EEPROM) Data

HPS3000-9-001 FRU (EEPROM) Data:

OFFSET		DEFINITION	SPEC VALUE	
(DEC)	(HEX)	(REMARKS)	(DEC)	(HEX)
		COMMON HEADER, 8 BYTES		
0	00	**FORMAT VERSION NUMBER** (Common header)	1	01
1	01	**INTERNAL USE AREA OFFSET** (In multiples of 8 bytes)	24	18
2	02	**CHASSIS INFO AREA OFFSET** (In multiples of 8 bytes)	1	01
3	03	**BOARD INFO AREA OFFSET** (No used)	0	00
4	04	**PRODUCT INFO AREA OFFSET** (In multiples of 8 bytes)	5	05
5	05	**MULTI RECORD AREA OFFSET** (In multiples of 8 bytes)	15	0F
6	06	**PAD** (reserved always 00H)	0	00
7	07	**ZERO CHECK SUM** (256 - (Sum of bytes 000d to 006d))	210	D2
		CHASSIS INFO AREA (32 BYTES)		
8	08	**FORMAT VERSION NUMBER** (Default value is 1.)	1	01
9	09	**CHASSIS INFO AREA LENGTH** (Default value is 0.)	0	00
10	0A	**CHASSIS TYPE** (Default value is 0.)	0	00
11	0B	**CHASSIS PART NUMBER Type/Length 10 Bytes allocation**	0	00
12 13 14 15 16 17 18 19 20 21	0C 0D 0E 0F 10 11 12 13 14 15	**CHASSIS PART NUMBER BYTES** (Default value is 0.)	0 0 0 0 0 0 0 0 0 0	00 00 00 00 00 00 00 00 00 00
22	16	**CHASSIS Type/Length 15 Bytes allocation 0CFH** (If used) (Default value is 0.)	0	00
23 24 25 26 27 28 29 30 31 32 33 34 35 36 37	17 18 19 1A 1B 1C 1D 1E 1F 20 21 22 23 24 25	**CHASSIS SERIAL NUMBER BYTES** (Default value is 0.)	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
38	26	**End Tag** (0C1h if used) (Default value is 0.)	0	00
39	27	**ZERO CHECK SUM** (From 08d to 38d if used)	255	FF
40	28	**FORMAT VERSION NUMBER**	1	01
41	29	**PRODUCT INFO AREA LENGTH** (In multiples of 8 bytes) 80 bytes are allocated. 80-bytes / 8 = 0AH.	10	0A
42	2A	**Language** (English = 19H)	25	19
43	2B	**MANUFACTURER NAME TYPE / LENGTH** (0C5H) 7-6: (11)b, 8-bit ASCII + Latin 1, 5-0: (000101)b, 5-byte allocation	197	C5

COMMUNICATION BUS DESCRIPTIONS

HPS3000-9-001 FRU (EEPROM) Data:

OFFSET		DEFINITION	SPEC VALUE	
(DEC)	(HEX)	(REMARKS)	(DEC)	(HEX)
COMPUTER/CHASSIS INFO AREA (32 BYTES)				
		MANUFACTURER'S NAME 5 bytes sequence		
44	2C	"A"	69	45
45	2D	"E"	78	4E
46	2E	"T"	80	50
47	2F	" "	32	20
48	30	" "	32	20
49	31	**PRODUCT NAME** Type/Length (0CEH) 7-6: (11)b, 8-Bit ASCII + Latin 1, 5-0: (001110)b, 14-Byte Allocation	206	CE
50	32	**PRODUCT NAME**	72	48
51	33	"H"	80	50
52	34	"P"	83	53
53	35	"S"	51	33
54	36	"3"	48	30
55	37	"0"	48	30
56	38	"0"	48	30
57	39	"0"	45	2D
58	3A	"-"	57	39
59	3B	"9"	0	00
60	3C	"-"	0	00
61	3D	"0"	0	00
62	3E	"0"	0	00
63	3F	"1"	0	00
64	40	**PART/MODEL NUMBER Type/Length (0CAH)** 7-6: (11)b, 8-bit ASCII + Latin 1, 5-0: (001000)b, 8-byte allocation	200	C8
65	41	**Power Supply Spare Kit Number**	0	00
66	42	**NOT APPLICABLE**	0	00
67	43		0	00
68	44		0	00
69	45		0	00
70	46		0	00
71	47		0	00
72	48		0	00
73	49	**Product Version Number Type/Length (0C2H)** 7-6: (11)b, 8-bit ASCII + Latin 1, 5-0: (000010)b, 2-byte allocation	194	C2
74	4A	**Product Version Number / Auto Rev**	XXX	XX
75	4B	*SHOULD TRACK MODEL REVISION on IPS Sec. 1.2	XXX	XX
76	4C	**Product Serial Number Type/Length (0CDH)** *PRODUCT SERIAL NUMBER IS BASED ON ASTEC SERIAL NUMBER FORMAT P/N: 417-00201000 7-6: (11)b, 8-bit ASCII + Latin 1, 5-0: (001101)b, 13-byte allocation	205	CD
		Product Serial Number: MODEL ID		
77	4D	"J"	72	48
78	4E	"8"	48	30
79	4F	"5"	56	38
80	50	"9"	49	31
81	51	**MANUFACTURING YEAR AND WEEK CODE**	XXX	XX
82	52	**Product Serial Number:** MANUFACTURING YEAR AND WEEK CODE *REFER TO 417-00201000 FOR DETAILS	XXX	XX

COMMUNICATION BUS DESCRIPTIONS

HPS3000-9-001 FRU (EEPROM) Data:

OFFSET		DEFINITION	SPEC VALUE	
(DEC)	(HEX)	(REMARKS)	(DEC)	(HEX)
83 84 85 86	53 54 55 56	**Product Serial Number:** UNIQUE SERIAL NUMBER *REFER TO 417-00201000 FOR DETAILS	XXX XXX XXX XXX	XX XX XX XX
87 88	57 58	**Product Serial Number:** MODEL REVISION ***SHOULD TRACK MODEL REVISION on IPS Sec. 1.2**	XXX XXX	XX XX
Product Serial Number: MANUFACTURING LOCATION *REFER TO 417-00201000 FOR DETAILS				
89	59	"P" (P for Laguna Philippines)	80	50
90	5A	**ASSET TAG** 7-6: (11)b, 8-bit ASCII + Latin 1, 5-0: (001000)b, 8-byte allocation	200	C8
91 92 93 94 95 96 97 98	5B 5C 5D 5E 5F 60 61 62	**NO ASSET TAG**	0 0 0 0 0 0 0 0	00 00 00 00 00 00 00 00
99	63	**FRU File ID** 7-6: (11)b, 8-bit ASCII + Latin 1, 5-0: (010001)b, 17-byte allocation	209	D1
100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116	64 65 66 67 68 69 6A 6B 6C 6D 6E 6F 70 71 72 73 74	**"Should track latest EEPROM Revision on IPS Sec. 1.2"** **NOT APPLICABLE**	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
117	75	**End of Fields Marker**	193	C1
118	76	**RESERVED**	0	00
119	77	**Zero Checksum From 040d to 118d**	XXX	XX
MULTI RECORD AREA: Power Supply Information 72 Bytes				
Power Supply Record Header				
120	78	**Record Type ID** (0x00 = Power Supply Information)	0	00
121	79	7: (0)b, End of List 6-4: (000)b, Reserved 3-0: (0010)b, Record Format Version	2	02
122	7A	**Record Length: 24 Bytes**	24	18
123	7B	**Record Checksum (Zero Checksum From 125d To 148d)**	100	64
124	7C	**Header Checksum (Zero Checksum From 120d To 123d)**	13	82

COMMUNICATION BUS DESCRIPTIONS

HPS3000-9 FRU (EEPROM) Data:

OFFSET		DEFINITION	SPEC VALUE	
(DEC)	(HEX)	(REMARKS)	(DEC)	(HEX)
		POWER SUPPLY RECORD		
125 126	7D 7E	**Overall Capacity** (Watts) 15-12: (0000)b, reserved 11-0: (11111010000)b, 3000W Stored with LSB first then MSB.	184 11	B8 0B
127 128	7F 80	**Peak VA** (Watts) 15-12: (0000)b, reserved 11-0: No peak VA rating Stored with LSB first then MSB	0 0	00 00
129	81	**Inrush Current** (Amps) 40Amps	40	28
130	82	**Inrush Interval** (ms) 0ms	0	00
131 132	83 84	**Low End Input Voltage Range 1**	0 0	00 00
133 134	85 86	**High End Input Voltage Range 1**	0 0	00 00
135 136	87 88	**Low End Input Voltage Range 2** 180V = 18000 (x10mV) Stored with LSB first then MSB.	80 70	50 46
137 138	89 8A	**High End Input Voltage Range 2** 264V = 26400 (x10mV) Stored with LSB first then MSB.	32 103	20 67
139	8B	**Low End Input Frequency Range, 47Hz**	47	2F
140	8C	**High End Input Frequency Range, 63Hz**	63	3F
141	8D	**A/C Dropout Tolerance in ms, 12ms**	12	0C
142	8E	**Binary Flags** 7-5: (000)b, reserved 4: (1)b, Tachometer Pulses Per Rotation / Predictive Fail Polarity (2 Pulses Per Rotation = 1; 1 Pulse Per Rotation = 0) OR (Signal Asserted(1) Indicates Failure = 0, Signal Deasserted(0) Indicates Failure = 1) 3: (1)b, Hot Swap / Redundancy Support 2: (0)b, AutoSwitch Support 1: (1)b, Power Factor Correction Support 0: (0)b, Predictive Fail Support	26	1A
143 144	8F 90	**Peak Wattage Capacity and Holdup Time** 15-12: (0000)b, Hold Up Time in Seconds = 00H (Not Specified) 11-0: (000000000000)b, Peak Capacity in Watts = 00H (Not Specified)	0 0	00 00
145 146 147	91 92 93	**Combined Wattage** **NOT APPLICABLE**	0 0 0	00 00 00
148	94	**Predictive Fail Tachometer Lower Threshold, Not applicable**	0	00
		48V DC Output Record Header		
149	95	Record Type ID (0x01 = DC Output)	001	01
150	96	**End Of List / Record Format Version Number** 7: (0)b, End of List 6-4: (000)b, Reserved 3-0: (0010)b, Record Format Version	002	02
151	97	**Record Length: 13 bytes**	013	0D
152	98	**Record Checksum** (Zero checksum from 154d to 166d)	194	C2
153	99	**Header Checksum** (Zero checksum from 149d to 152d	46	2E

COMMUNICATION BUS DESCRIPTIONS

HPS3000-9-001 FRU (EEPROM) Data:

OFFSET		DEFINITION	SPEC VALUE	
(DEC)	(HEX)	(REMARKS)	(DEC)	(HEX)
		+48V DC OUTPUT RECORD		
154	9A	**48V Output Information** 7: (0)b, Standby 6-4: (000)b, Reserved 3-0: (0001)b, Output Number 1	001	01
155 156	9B 9C	**Nominal Voltage** 48V = 4800 (x10mV) Stored with LSB first then MSB.	192 018	C0 12
157 158	9D 9E	**Maximum Negative Voltage Deviation** 43.2V = 4320 (x10mV) Stored with LSB first then MSB.	224 016	E0 10
159 160	9F A0	**Maximum Positive Voltage Deviation** 52.8V = 5280 (x10mV) Stored with LSB first then MSB.	160 020	A0 14
161 162	A1 A2	**Ripple And Noise pk -pk 10Hz To 30MHz (mV)** 480mV Stored with LSB first then MSB.	224 001	E0 01
163 164	A3 A4	**Minimum Current Draw (10mA)** 1A = 100 (x10mA) Stored with LSB first then MSB.	100 000	64 00
165 166	A5 A6	**Maximum Current Draw (10mA)** 62.50A = 6250 (x10mA) Stored with LSB first then MSB.	106 024	6A 18
		5VSB OUTPUT RECORD HEADER		
167	A7	**Record Type ID** (0x01 = DC Output)	001	01
168	A8	**End Of List/Record Format Version Number** 7: (1)b, End of List 6-4: (000)b, Reserved 3-0: (0010)b, Record Format Version	130	82
169	A9	**Record Length: 20 bytes**	020	14
170	AA	**Record Checksum** (Zero checksum from 172d to 191d)	219	DB
171	AB	**Header Checksum** (Zero checksum from 167d to 170d)	142	8E
		5VSB DC OUTPUT RECORD		
172	AC	**5VSB Output Information** 7: (1)b, Standby (Bit = 1 to indicate standby output) 6-4: (000)b, Reserved 3-0: (0010)b, Output Number 2 = 010b	130	82
173 174	AD AE	**Nominal Voltage** 5V = 500 (x10mV) Stored with LSB first then MSB.	244 001	F4 01
175 176	AF B0	**Maximum Negative Voltage Deviation** 4.8V = 480 (x10mV) Stored with LSB first then MSB.	224 001	E0 01
177 178	B1 B2	**Maximum Positive Voltage Deviation** 5.2V = 520 (x10mV) Stored with LSB first then MSB.	008 002	08 02
179 180	B3 B4	**Ripple And Noise pk-pk 10Hz To 30MHz** (mV) 100mV Stored with LSB first then MSB.	100 000	64 00
181 182	B5 B6	**Minimum Current Draw** (10mA) 0.5A = 50 (x10mA) Stored with LSB first then MSB.	050 000	32 00

COMMUNICATION BUS DESCRIPTIONS

HPS3000-9-001 FRU (EEPROM) Data:

OFFSET		DEFINITION	SPEC VALUE	
(DEC)	(HEX)	(REMARKS)	(DEC)	(HEX)
183 184	B7 B8	**Maximum Current Draw** (10mA) 3.00A = 300(x10mA) Stored with LSB first then MSB.	044 001	2C 01
185	B9	**Reserved**	000	00
186	BA	**Reserved**	000	00
187	BB	**Reserved**	000	00
188	BC	**Reserved**	000	00
189	BD	**Reserved**	000	00
190	BE	**Reserved**	000	00
191	BF	**Reserved**	000	00
INTERNATIONAL USE AREA, 64 BYTES				
192	C0	**Format Version Number** 7:4 - Reserved, write as 0000b 3:0 - Format Version Number = 1h for this specification.	001	01
193	C1		0	00
194	C2		0	00
195	C3		0	00
196	C4		0	00
197	C5		0	00
198	C6		0	00
199	C7		0	00
200	C8		0	00
201	C9		0	00
202	CA		0	00
203	CB		0	00
204	CC		0	00
205	CD		0	00
206	CE		0	00
207	CF		0	00
208	D0		0	00
209	D1		0	00
210	D2		0	00
211	D3		0	00
212	D4		0	00
213	D5		0	00
214	D6		0	00
215	D7		0	00
216	D8		0	00
217	D9		0	00
218	DA		0	00
219	DB		0	00
220	DC		0	00
221	DD		0	00
222	DE		0	00
223	DF		0	00
224	E0		0	00
225	E1		0	00
226	E2		0	00
227	E3		0	00
228	E4		0	00
229	E5		0	00
230	E6		0	00
231	E7		0	00
232	E8		0	00
233	E9		0	00

COMMUNICATION BUS DESCRIPTIONS

HPS3000-9-001 FRU (EEPROM) Data:

OFFSET		DEFINITION	SPEC VALUE	
(DEC)	(HEX)	(REMARKS)	(DEC)	(HEX)
234	EA		0	00
235	EB		0	00
236	EC		0	00
237	ED		0	00
238	EE		0	00
239	EF		0	00
240	F0		0	00
241	F1		0	00
242	F2		0	00
243	F3		0	00
244	F4		0	00
245	F5		0	00
246	F6		0	00
247	F7		0	00
248	F8		0	00
249	F9		0	00
250	FA		0	00
251	FB		0	00
252	FC		0	00
253	FD		0	00
254	FE		0	00
255	FF	**Zero CHECKSUM of Internal Use Area** (if used).	255	FF

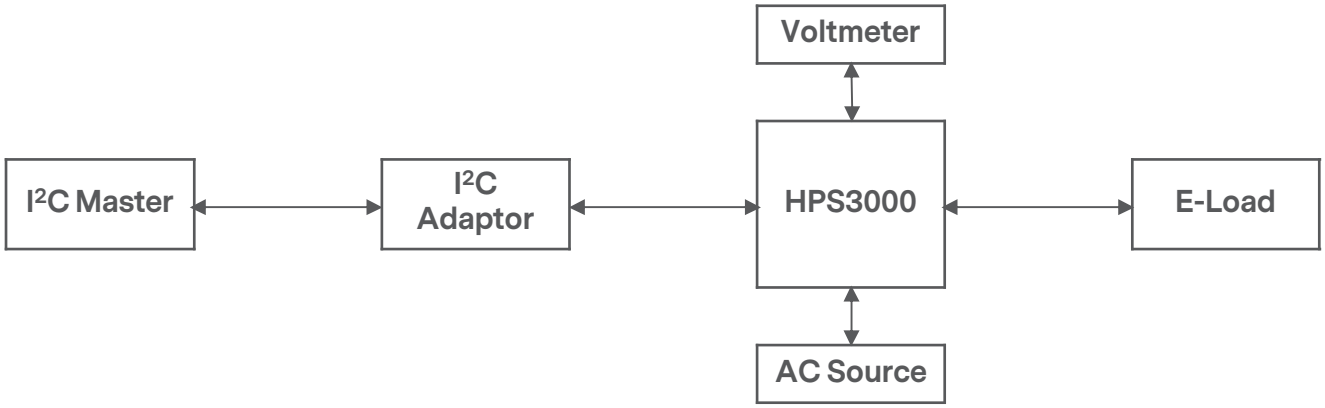
PMBus™ SPECIFICATIONS

The HPS3000 is compliant with the industry standard PMBus™ protocol for monitoring and control of the power supply via the I²C interface port.

HPS3000 Series PMBus™ General Instructions

Equipment Setup

The following is typical I²C communication setup:



PMBus™ Writing Instructions

When writing to any PMBus™ R/W registers, ALWAYS do the following:

Disable Write Protect (command 10h) by writing any of the following accordingly:

Levels: 00h - Enable writing to all writeable commends

20h - Disables write except 10h, 01h, 00h, 02h and 21h commands

40h - Disables write except 10h, 01h, and 00h commends

80h - Disable write except 0x00h

To save changes on the USER PMBus™ Table:

Use send byte command: 15h STORE_USER_ALL

To save changes on the DEFAULT PMBus™ Table:

Use send byte command: 11h STORE_DEFAULT_ALL

Wait for 5 seconds, turn-off the PSU, wait for another 5 seconds before turning it on.

PMBus™ SPECIFICATIONS

The HPS3000-9 Series Supported PMBus™ Command List:

Command Code	Command Name	Default Value	Access Type	Data Bytes	Data Format	Description
00h	PAGE	00	R/W	1		Configure, control and monitor function
01h	OPERATION	80	R/W	1		Used to turn the unit ON/OFF in conjunction with the input PS_ON pin.
	b7:6	10				01 - Soft turn OFF (with sequencing) 10 - PSU ON
	b5:4	00				
	b3:2	00				
	b1:0	00				Reserved
02h	ON_OFF_CONFIG	1C	R	1		Configures the combination of CONTROL pin and serial communication commands needed to turn the unit ON/OFF.
	b7:5	00				Reserved
	b4 - Enable PS_ON pin and serial communication control.	1				0 - Unit powers up any time power is present regardless of the state of PS_ON pin. 1 - Unit powers up as dictated by PS_ON pin and OPERATION command (b3:0).
	b3 - Serial communication control	1				0 - Unit ignores ON/OFF portion of the OPERATION command. 1 - Enables serial communication ON/OFF portion of OPERATION command. Requires PS_ON pin to be asserted for the unit to start and energize the output.
	b2 - Sets how the unit responds to PS_ON pin	1				0 - Unit ignores CONTROL pin. (ON/OFF controlled by OPERATION command). 1 - Unit requires CONTROL pin to be asserted to start the unit.
	b1 - PS_ON pin polarity	0				0 - Active low (Pull low to start the unit) 1 - Active high (Pull high to start the unit)
	b0 - PS_ON pin action	0				0 - Use programmed turn ON/OFF delay. 1 - Turn OFF the output and stop transferring energy to the output as fast as possible.
03h	CLEAR_FAULTS	0	S			
10h	WRITE_PROTECT	00	R/W	1		Used to control writing to the PMBus device. 80h - Disables write except 10h 40h - Disables write except 10h, 01h, 00h 20h - Disables write except 10h, 01h, 00h, 02h and 21h commands 00h - Enables write to all writeable commands.

PMBus™ SPECIFICATIONS

The HPS3000-9 Series Supported PMBus™ Command List:

Command Code	Command Name	Default Value	Access Type	Data Bytes	Data Format	Description
15h	STORE_USER_ALL	-	S	0		Copies the operating memory table to the matching USER non-volatile memory.
16h	RESTORE_USER_ALL	-	S	0		Copies the entire USER non-volatile memory to the operating memory table.
19h	CAPABILITY	90	R	1		Provides a way for the hosts system to determine some key capabilities of a PMBus device.
	b7 - Packet Error Checking	1				0 - PEC not supported 1 - PEC supported
	b6 - Maximum Bus Speed	0				0 - Maximum supported bus speed, 100KHz 1 - Maximum supported bus speed, 400KHz
	b5 - SMBALERT#	0				0 - SMBus alert pin not supported 1 - SMBus alert pin supported
	b4:0					Reserved
20h	VOUT_MODE	17	R	1		Specifies the mode and parameters of output voltage related data formats.
21h	VOUT_COMMAND	6600	R/W	2	Linear	Sets 48V output voltage reference Vout command sends discreet value to change or trim output voltage. The value acts as digital reference of the power supply after additional operations are performed (to make the representation compatible). Affects OVP_WARNING and FAULT LIMIT, as well as POWER_GOOD_ON/OFF level.
22h	VOUT_TRIM	0000	R/W	2		0
23h	VOUT_CAL_OFFSET	0000	R/W	2		Variable. Used by Factory to trim Vout Default before trimming, 0000.
24h	VOUT_MAX	7033	R	2	Linear	Sets the max adjustable output voltage limit. 56.1V.
31h	POUT_MAX	13B9	R	2	Linear	Sets the operating power limit condition. 3812W
35h	VIN_ON	EAC0	R	2	Linear	Sets the value of input, in volts, at which the unit should start. ACGOOD 88Vdc
36h	VIN_OFF	EA80	R	2	Linear	Sets the value of input, in volts, at which the unit should stop power conversion. ACBAD 80Vac

PMBus™ SPECIFICATIONS

The HPS3000-9 Series Supported PMBus™ Command List:

Command Code	Command Name	Default Value	Access Type	Data Bytes	Data Format	Description
3Ah	FAN_ CONFIG_1_2	99	R	1		Used to configure up to 2 fans associated with one PMBus device
	b7	1				1 - Fan is installed in position 1. 0 - No fan is installed in position 1.
	b6	0				1 - Fan is commanded in RPM. 0 - Fan is commanded in DC.
	b5:4	01				00 - 1 pulse per revolution 01 - 2 pulses per revolution 10 - 3 pulses per revolution 11 - 4 pulses per revolution
	b3	0				1 - Fan is installed in position 2. 0 - No fan is installed in position 2.
	b2	0				1 - Fan is commanded in RPM. 0 - Fan is commanded in DC.
	b1:0	00				00 - 1 pulse per revolution 01 - 2 pulses per revolution 10 - 3 pulses per revolution 11 - 4 pulses per revolution
3Bh	FAN_COMMAND_1	0000	R/W	2	Linear	Adjusts the operation of the Fans. The device may override the command, if it requires higher value, to maintain proper device temperature. RPM Control - Commands Speeds from 0-20096 RPM. Duty cycle Control - Commands Speeds from 0 to 100%.
3Ch	FAN_COMMAND_2	0000	R/W	2	Linear	Adjusts the operation of the Fans. The device may override the command, if it requires higher value, to maintain proper device temperature. RPM Control - Commands Speeds from 0-20096 RPM. Duty cycle Control - Commands Speeds from 0 to 100%.
40h	VOUT_OV_FAULT_LIMIT	7333	R/W	2	Linear	Sets output over voltage threshold. (57.6V)
41h	VOUT_OV_FAULT_RESPONSE	80	R	1		Unit latches OFF. Resets on PSON or CONTROL pin recycle or AC recycle.
42h	VOUT_OV_WARN_LIMIT	6E61	R/W	2	Linear	Sets over-voltage warning threshold. (55.2V)
43h	VOUT_UV_WARN_LIMIT	5993	R/W	2	Linear	Sets under-voltage warning threshold. (44.8V)
44h	VOUT_UV_FAULT_LIMIT	5200	R/W	2	Linear	Sets under-voltage fault threshold. (41V)
45h	VOUT_UV_FAULT_RESPONSE	80	R	1		Turn PSU OFF
46h	IOUT_OC_FAULT_LIMIT	EA70	R	2	Linear	Sets the over current threshold in Amps. (78A for Hi Line)

PMBus™ SPECIFICATIONS

The HPS3000-9 Series Supported PMBus™ Command List:

Command Code	Command Name	Default Value	Access Type	Data Bytes	Data Format	Description
47h	IOUT_OC_FAULT_RESPONSE	80	R	1		OCP ride through, if OCP persists.
4Ah	IOUT_OC_WARN_LIMIT	EA24	R	2	Linear	Sets the over current warning threshold in Amps. (68.5A for Hi Line)
4Fh	OT_FAULT_LIMIT	E320	R	2	Linear	Secondary ambient temperature fault threshold, in degree C. (50degC)
50h	OT_FAULT_RESPONSE	C0	R	1		Turn PSU OFF and will retry indefinitely.
51h	OT_WARN_LIMIT	E2D0	R	2	Linear	Secondary ambient temperature warning threshold, in degree C. Operating limit refer to section 3.1. (45 degC)
55h	VIN_OV_FAULT_LIMIT	FA26	R	2	Linear	Sets input over-voltage threshold. (275Vac)
56h	VIN_OV_FAULT_RESPONSE	00	R	1		
59h	VIN_UV_FAULT_LIMIT	EA80	R	2	Linear	(80Vac)
5Ah	VIN_UV_FAULT_RESPONSE	C0	R	1		
5Bh	IIN_OC_FAULT_LIMIT	DA80	R	2	Linear	Sets the threshold for input current that causes over-current fault within 100ms. (20A)
5Ch	IIN-OC-FAULT_RESPONSE	80	R	1		Turn PSU OFF. Cleared upon AC recycle.
60h	TON_DELAY	F320	R	2	Linear	Sets the time (sec), from start condition (Power ON) until the output starts to rise. (2sec)
61h	TON_RISE	F2A8	R	2	Linear	Sets the time (ms), for the output rises from 5 to regulation. (300ms)
78h	STATUS_BYTE	-	R	1		Returns the summary of critical faults.
	b7 - BUSY	-				A fault was declared because the device was busy and unable to respond.
	b6 - OFF	-				Unit is OFF.
	b5 - VOUT_OV	-				Output over-voltage fault has occurred.
	b4 - IOUT_OC	-				Output over-current fault has occurred.
	b3 - VIN_UV	-				An input under-voltage fault has occurred.
	b2 - TEMPERATURE	-				A temperature fault or warning has occurred.
	b1 - CML	-				A communication, memory or logic fault has occurred.
	b0 - NONE OF THE ABOVE	-				A fault warning not listed in bits[7:1] has occurred.

PMBus™ SPECIFICATIONS

The HPS3000-9 Series Supported PMBus™ Command List:

Command Code	Command Name	Default Value	Access Type	Data Bytes	Data Format	Description
79h	STATUS_WORD	-	R	2		Summary of units fault and warning status.
	b15 - VOUT					An output voltage fault or warning has occurred.
	b14 - IOUT/POUT					An output current or power fault or warning has occurred.
	b13 - INPUT					An input voltage, current or power fault or warning as occurred.
	b12 - MFR					A manufacturer specific fault or warning has occurred.
	b11 - POWER_GOOD#					The POWER_GOOD signal is de-asserted.
	b10 - FANS					A fan or airflow fault or warning has occurred.
	b9 - OTHER					A bit in STATUS_OTHER is set.
	b8 - UKNOWN					A fault type not given in bits [15:1] of the STATUS_WORD has been detected.
	b7 - BUSY					A fault was declared because the device was busy and unable to respond.
	b6 - OFF					Unit is OFF.
	b5 - VOUT_OV					Output over-voltage fault has occurred.
	b4 - IOUT_OC					Output over-current fault has occurred.
	b3 - VIN_UV					An input under-voltage fault has occurred.
	b2 - TEMPERATURE					A temperature fault or warning has occurred.
	b1 - CML					A communication, memory or logic fault has occurred.
	b0 - NONE_OF_THE_ABOVE					A fault or warning not listed in bits[7:1] of this byte has occurred.
7Ah	STATUS_VOUT	-	R	1		Output voltage related faults and warnings.
	b7					VOUT over-voltage fault
	b6					VOUT over-voltage warning
	b5					VOUT under-voltage warning
	b4					VOUT under-voltage fault
	b3					VOUT_MAX warning, an attempt has been made to set output to a value higher that the highest permissible voltage. Not supported
	b2					TON_MAX_FAULT
	b1					TOFF_MAX warning Not supported
	b0					Reserved

PMBus™ SPECIFICATIONS

The HPS3000-9 Series Supported PMBus™ Command List:

Command Code	Command Name	Default Value	Access Type	Data Bytes	Data Format	Description
7Bh	STATUS_IOUT	-	R	1		Output current related faults and warnings
	b7					IOUT over current fault
	b6					IOUT over current and low voltage shutdown fault
	b5					IOUT over current warning
	b4					IOUT under current fault
	b3					Current share fault
	b2					Power Limiting. Not supported
	b1					POUT over power fault
	b0					POUT over power warning
7Ch	STATUS_INPUT	-	R	1		Input related faults and warnings
	b7					VIN over voltage fault
	b6					VIN over voltage warning
	b5					VIN under voltage warning
	b4					VIN under voltage fault
	b3					Unit is OFF for insufficient input Voltage.
	b2					IIN overcurrent fault.
	b1					IIN overcurrent warning
	b0					PIN overpower warning.
7Dh	STATUS_TEMPERATURE	-	R	1		Temperature related faults and warnings
	b7					Over temperature fault
	b6					Over temperature warning
	b5					Under temperature warning.
	b4					Under temperature fault.
	b3:0					Reserved
7Eh	STATUS_CML	-	R	1		Communications, logic and memory
	b7					Invalid or unsupported command received.
	b6					
	b5					Packet error check failed
	b4					Memory fault detect, CRC error
	b3					
	b2					
	b1					
	b0					

PMBus™ SPECIFICATIONS

The HPS3000-9 Series Supported PMBus™ Command List:

Command Code	Command Name	Default Value	Access Type	Data Bytes	Data Format	Description
80h	STATUS_MFR_SPECIFIC	-	R	1		Manufacturer Status Codes (Debugging Purposes)
	b7					Bulk OK, 1 - Bulk is within range and is ready for use.
	b6					Not Used
	b5					Running Sckt
	b4					Start-Up Sckt
	b3					Standby Under Voltage
	b2					Standby OCP
	b1					Rail Fault
	b0					PS_ON Pin Status: 1 - asserted, 0 - deasserted
81h	STATUS_FANS_1_2	-	R	1		
	b7					Fan 1 fault
	b6					Fan 2 fault
	b5					Fan 1 warning
	b4					Fan 2 warning
	b3					Fan_1 speed overridden
	b2					Fan_2 speed overridden
	b1					
	b0					
88h	READ_VIN	-	R	2	Linear	Returns input voltage in Volts ac.
89h	READ_IIN	-	R	2	Linear	Returns input current in Amperes
8Ah	READ_VCAP	-	R	2	Linear	Returns bulk capacitor voltage in Volts
8Bh	READ_VOUT	-	R	2	Linear	Returns the actual, measured voltage in Volts.
8Ch	READ_IOUT	-	R	2	Linear	Returns the output current in Amperes.
8Dh	READ_TEMPERATURE_1	-	R	2	Linear	PSU inlet temperature sensor
8Eh	READ_TEMPERATURE_2	-	R	2	Linear	Primary heatsink of the PFC MOSFETs temp sensor
90h	READ_FAN_SPEED_1	-	R	2	Linear	Speed of fan 1
91h	READ_FAN_SPEED_1	-	R	2	Linear	Speed of fan 2
96h	READ_POUT	-	R	2	Linear	Returns the output power, in Watts.
97h	READ_PIN	-	R	2	Linear	Returns the input power, in Watts.
98h	PMBUS_REVISION	11	R	1	Linear	Reads the PMBus revision number.
	b7:5	0001				Part 1 revision 0000 - Revision 1.0 0001 - Revision 1.1
	b4:0	0001				Part 2 revision 0000 - Revision 1.0 0001 - Revision 1.1
99h	MFR_ID	07 45 4D 45 52 53 30 4E	R	8		Abbrev or symbol of manufacturers name.
9Ah	MFR_MODEL	09 48 50 53 33 30 30 30 2D 39	R	10		Manufacturers model number,

PMBus™ SPECIFICATIONS

The HPS3000-9 Series Supported PMBus™ Command List:

Command Code	Command Name	Default Value	Access Type	Data Bytes	Data Format	Description
9Bh	MFR_REVISION	02 30 41	R	3		Manufacturers, revision number,
9Ch	MFR_LOCATION	04 50 68 69 6C	R	4		Manufacturers facility, ASCII format
A0h	MFR_VIN_MIN	EAD0	R	2	Linear	Minimum input voltage (90Vdc)
A1h	MFR_VIN_MAX	FA10	R	2	Linear	Maximum input voltage (264Vdc)
A2h	MFR_IIN_MAX	DA30	R	2	Linear	Maximum input current (19A)
A3h	MFR_PIN_MAX	1341	R	2	Linear	Maximum input power (3372W for high line)
A4h	MFR_VOUT_MIN	5BCD	R	2	Linear	Minimum output voltage Regulation window (45.9V)
A5h	MFR_VOUT_MAX	7033	R	2	Linear	Maximum output voltage Regulation window (56.1V)
A6h	MFR_IOUT_MAX	E3E8	R	2	Linear	Maximum output current (62.5A for high line)
A7h	MFR_POUT_MAX	12EE	R	2	Linear	Maximum output power (3000W for high line)
A8h	MFR_TAMBIENT_MAX	E280	R	2	Linear	Maximum operating ambient temperature (secondary ambient) (40degC)
ABh	MFR_EFFICIENCY_HL	0E C8 00 00 00 00 00 00 00 00 00 EE 12 5A 00	R		Direct	Efficiency at high line condition

APPLICATION NOTES

Current Sharing

The HPS3000 series' main output V_O is equipped with current sharing capability. This will allow up to 4 power supplies to be connected in parallel for higher power application. Current share accuracy is typically 10% of full load. Below 10% total loading, there is no guarantee of output current sharing.

Redundancy / Fault Tolerance

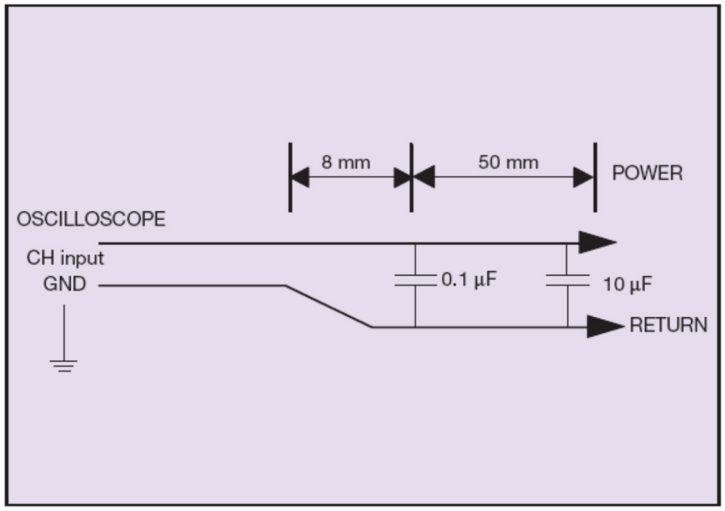
The HPS3000 series power supplies will allow up to 4 power supplies to be connected in a N+1 redundant load.

Any failure of one power supply in parallel as well as hot swapping shall not cause more than a 5% change in any output. The failure of one or more supplies will not cause the remaining supplies to violate any of the input or output specifications noted in this specification including all status signals.

APPLICATION NOTES

Output Ripple and Noise Measurement

The setup outlined in the diagram below has been used for output voltage ripple and noise measurements on the HPS3000 series. When measuring output ripple and noise, a scope jack in parallel with a 0.1uF ceramic chip capacitor, and a 10uF tantalum capacitor will be used. Oscilloscope can be set to 20MHz bandwidth for this measurement.



RECORD OF REVISION AND CHANGES

Issue	Date	Description	Originators
1.6	05.27.2020	Update safety cert from 60950 to 62368-1	C. Liu
1.7	06.01.2022	Add UKCA mark	C. Liu
1.8	11.03.2022	Add MTBF and life information	C. Liu

ABOUT ADVANCED ENERGY

Advanced Energy (AE) has devoted more than three decades to perfecting power for its global customers. AE designs and manufactures highly engineered, precision power conversion, measurement and control solutions for mission-critical applications and processes.

Our products enable customer innovation in complex applications for a wide range of industries including semiconductor equipment, industrial, manufacturing, telecommunications, data center computing, and medical. With deep applications know-how and responsive service and support across the globe, we build collaborative partnerships to meet rapid technological developments, propel growth for our customers, and innovate the future of power.

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